MEAT RESEARCH
NEWS LETTER
1969-71

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MEAT RESEARCH NEWS LETTER

189

CSIRO

NUMBER : 69/1

MEAT RESEARCH LABORATORY

DATE : 3rd. February, 1969

P.O. BOX 12. (CNR. CREEK AND WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170. TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

SPOILAGE OF FRESH MEAT

The Effects of Time and Temperature

Fresh meat is a perishable commodity which is subject to spoilage by bacteria even at refrigerator temperatures very close to freezing.

These bacteria are single celled organisms which are so small that it would take about 400 million to equal the size of a grain of sugar. Their growth may result in slime, sour odour, taint or changes in the wholesomeness of the meat.

Meat, freshly slaughtered under clean conditions, has only a few thousand bacteria per sq. inch (generally 1,000 to 10,000 per sq.inch).

When spoilage is advanced the bacterial colonies group together to give the appearance of slime. This occurs at about 1,000 million bacteria per sq. inch, or an increase of nearly 1,000,000 times.

As bacteria multiply by each cell dividing with two, an increase of 1,000,000 inevitably ensues when 20 divisions have occurred. The objective in fresh meat preservation is to choose storage conditions which will delay this 1,000,000 fold increase.

How many of these divisions do you wish to take place in your fresh meats prior to sale? If, for example, you permit 17 or 18 divisions to take place, only 2 or 3 remain before your customer notices the meat has spoiled. The meat is judged to have a poor keeping quality. If, on the other hand, you allow only 4 or 5 divisions, then 15 or 16 remain before the customer is likely to detect taints. The keeping quality is then judged to be excellent.

The rate at which bacteria grow on meat surfaces depends on the type of organism, nature of the storage atmosphere, the amount of water in or on the tissues and, above all, the temperature.

The accompanying graph summarises results obtained in various laboratories for effect of temperature on growth of spoilage bacteria on moist meat in air. It is under these conditions that spoilage develops most rapidly. Situations where the supply of moisture is adequate are quite commonly encountered, e.g., in chill rooms with high relative humidities of say 95 per cent or more, in insulated delivery vehicles, in packaged fresh meats and on equipment in meatworks or boning rooms where surfaces become covered with a film of meat juice.

In such circumstances, the time for one bacterial division depends on temperature. At 70°-80°F it may be an hour, or even less. At 50°F, the temperature of boning rooms, it is still not much above 2 hours, some 5 hours at 40°F and 10 or 12 hours at 30°-32°F. At each temperature there is a corresponding time required for one division. Consequently we can control bacterial growth by simply controlling time and temperature. Any additional time in storage or during transport will inevitably mean some additional growth of bacteria, the number of divisions in this period being determined by the temperature of the meat.

Low temperatures will delay the production of slime by slowing the growth of bacteria and increasing the time taken for the 20 divisions to occur. You can control the amount of bacterial growth in your products by measuring and controlling time and temperature.

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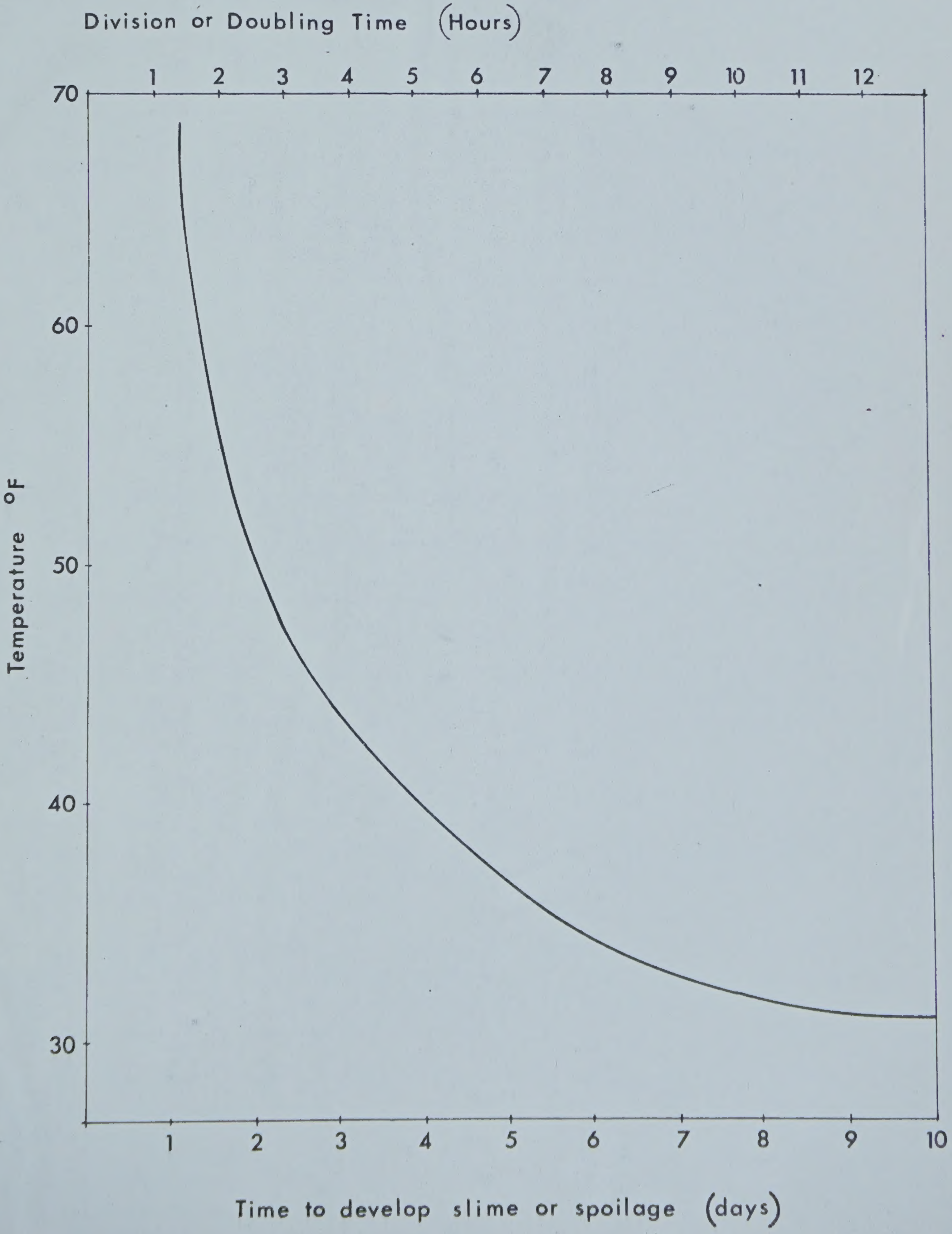
NEWS JOTTINGS

Next issue will be Estimation of Fat by the Refractometer Method.

Current work by the Laboratory, which we consider will be of importance to the Industry, concerns ageing of meat in permeable films under controlled atmosphere.

Relationship between Holding Temperature and Rate of Growth of Spoilage Bacteria on moist meat.



MEAT RESEARCH NEWS LETTER

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MEAT RESEARCH LABORATORY

DATE: 7th. March, 1969

P.O. BOX 12 (CNR CREEK AND WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170 TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

A REFRACTOMETRIC METHOD FOR THE ESTIMATION OF FAT IN MEAT

The accuracy of any method of fat estimation depends on:

(a) obtaining representative samples for analysis

(b) precision of method for determining fat contents of sample.

The importance of controlling fat contents within narrow limits is well known. Too high a fat content may lead to claims and too low a fat content may mean that the processor is not getting the best monetary return possible.

The purpose of this News Letter is to set out information on a new method of fat analysis so that Management can compare it with their own technique and make their own decision concerning its use. Alternative methods are available and can be obtained from the Meat Research Laboratory on request.

Refractometric methods for the estimation of fat are based on observations of the refractive index (R.I.) of solvents containing fat. The R.I. is related to the quantity of fat extracted from the meat sample by the solvent employed.

The procedure involves placing the meat sample and solvent in a blender. Maceration results in very rapid transfer of the fat into the solvent. The concentration in the solvent is then determined immediately by taking some of the solution, placing on the prism of a refractometer, reading the R.I. and determining fat percentage from a chart. One analyst can analyse six samples per hour.

Advantages of the Method

(1) The method is fast. It takes about 10 minutes from commencement of the preparation of macerated sample to reading of fat percentage. Multiple samples can be prepared and held at 40°C before measurement of the refractive index.

(2) The method is easy to use and involves little skill and training.

(3) A larger sample is used for extraction of fat than in some currently used methods. The relatively large sample of 50 gm or more reduces the sampling error compared to samples of around 10 gm.

(4) The method is adequately accurate. For fat contents under 20%, the results on 50 gm samples are within 1% of the value obtained by the AOAC ether solvent extraction method. For fat contents over 20%, the error may be up to 2%

(5) The extracting materials are relatively cheap. Ortho-dichlorobenzene, which can be obtained from chemical supply houses, costs approximately $12.00 per gallon. When not recovering the ortho-dichlorobenzene, the solvent cost per 50 gm meat sample test is 26.5¢. When recovering the ortho-dichlorobenzene, the solvent cost per test is approximately 2.5¢.

Disadvantages of the Method:

(1) The refractometer and associated equipment are relatively expensive. The Meat Research Laboratory uses an Abbè refractometer made by Fuji Optical Works, Japan, and this sells for about $350 in Australia. The constant temperature water supply used is a Haake Ultra-thermostat and costs about $400. However, any constant temperature water supply which is at 40°C ± 0.5°C can be used to maintain the temperature in the refractometer and suitable equipment can be obtained for about $100. A suitable blender costs $100.

(2) Ortho-dichlorobenzene is moderately toxic and has a penetrating odour which induces sneezing in some people. Also, it could taint meat. It is necessary to provide a fume cupboard or exhaust fan over the area used for fat estimation and also for recovery of the solvent.

(3) Ortho-dichlorobenzene is inflammable and has a flash point of 79°C (174°F).

(4) Because of the above disadvantages, the method should only be used in a well ventilated laboratory under the supervision of a chemist or quality control officer

Method: See attached sheets.

THE REFRACTOMETRIC METHOD FOR THE ESTIMATION OF FAT IN MEAT

Equipment:

Balance - good physical balance with accuracy of 0.1g.

Refractometer, Constant temperature circulating water bath.

Steam distillation apparatus (for recovery of ortho-dichlorobenzene).

Beakers, funnels, flasks, filter papers (Whatman No. 4), Kleenex tissues, thermometer, hot plate.

Blender (Waring or M.S.E. Atomix).

Materials:

Ortho-dichlorobenzene

Diethyl ether (for cleaning refractometer prism)

Procedure:

(1) The meat is sampled by the core technique. To attain accuracy, at least 50 gm should be used for each test.

(2) The core samples are cut into smaller sections and the weighed meat sample is placed in a high speed blender. A quantity of ortho-dichlorobenzene is added to the meat and the mixture macerated for 3-4 minutes. The number of mls. of ortho-dichlorobenzene to be added is equal to twice the number of grams in the meat sample, e.g. 60 gms. meat to 120 mls. ortho-dichlorobenzene. The mixture is decanted from the blender bowl and filtered through a Whatman No.4 filter paper (any method which thoroughly separates the fat containing solvent would be suitable).

It is desirable to hold the filtered solution in a water bath at 40°C until the R.I. is measured.

(3) The refractometer prism is cleaned with a tissue soaked in ether and wiped dry with a clean tissue paper. The filtered solution is applied to the refractometer prism and wiped off. A further addition of several drops of the solution is applied to the prism, and the R.I. of the mixture read according to the instructions with the instrument. It is essential to operate the instrument at 40°C ± 0.5°C (e.g. by circulation of temperature controlled water) and to maintain the solution to be measured at the same temperature. For a 1°C change in temperature, there will be an approximate change of 0.0004 in R.I. If the solution is not 40°C when put on the prism, it will quickly equilibrate to that temperature (an indication of this is the changing R.I. reading until the temperature becomes constant).

To obtain satisfactory fat estimations, it is essential that the R.I. be accurate to 0.0002. To ensure this, 2-3 readings are taken on the sample (or until consecutively identical readings are obtained). The prism is wiped clean with a tissue, and a further application of the same filtered solution placed on the prism and read in the same manner. If the readings of the two samples are not within 0.0002, then the prism is wiped clean and another sample of the same solution read. The readings of the 2-3 samples are averaged.

(4) The fat content corresponding to the R.I. is read from a calibration chart relating R.I. to percentage fat content. A copy of the calibration chart used at the Meat Research Laboratory is attached, but it is recommended that where works quality control laboratories have the facilities, they should prepare their own calibration chart.

The chart shown is based on 50 grams of meat and 100 ml solvent at 40°C and is applicable for fat contents up to 40%. For higher fat contents, half the quantity of meat, or double the volume of solvent should be used (and the percentage fat reading doubled).

Alternative Procedures:

(a) A mixture of ortho-dichlorobenzene and di-iso octyl phthalate can be used. The mixed solvent has less odour than the single solvent but is not as sensitive. When not recovering the ortho-dichlorobenzene, the solvent cost per 50 gm meat sample test is 16.5¢. When recovering the ortho-dichlorobenzene, the solvent cost per test is approximately 4.5¢.

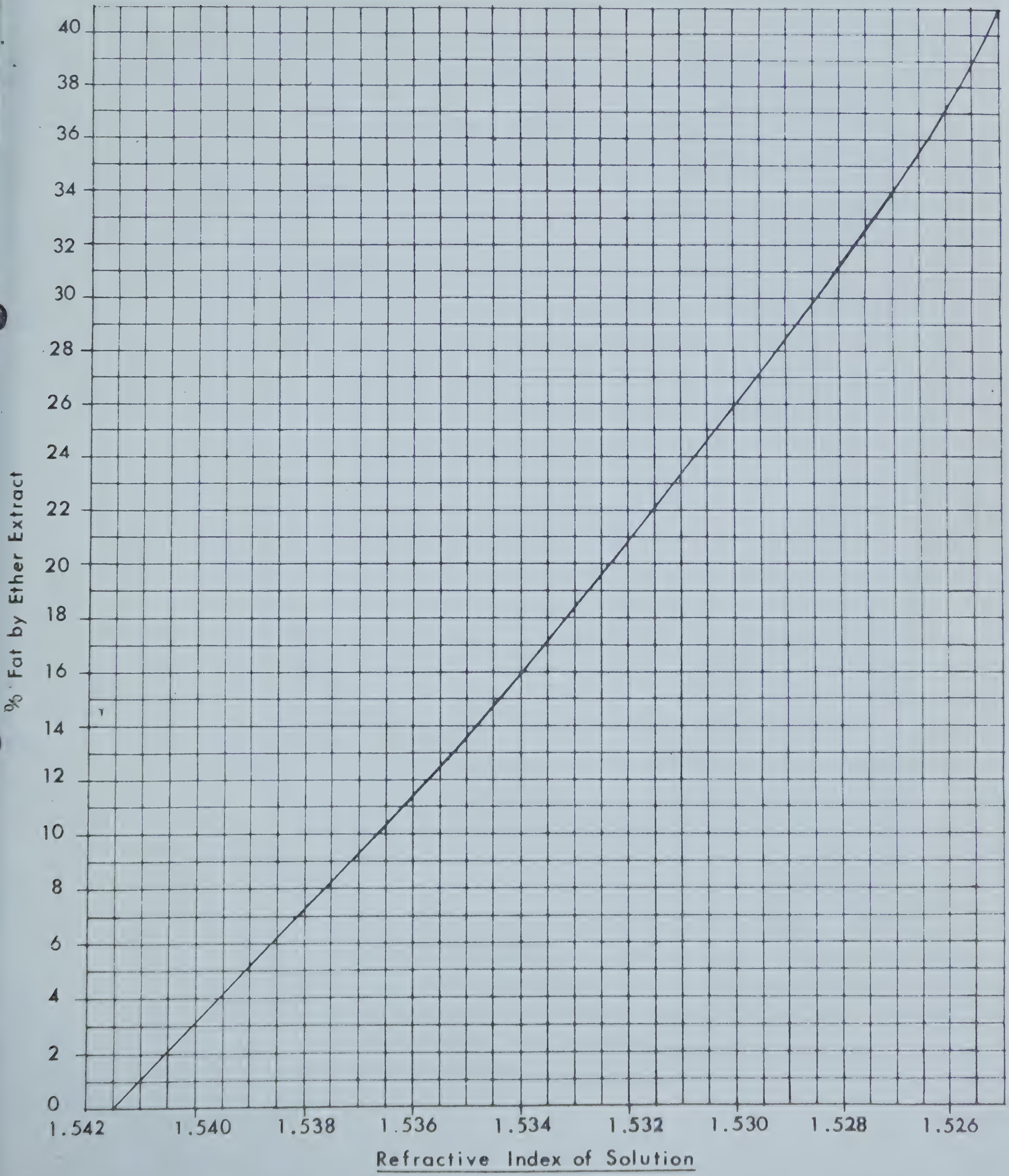
(b) If a blender is not available, the meat sample can be comminuted by mincing. The analytical procedure is slightly different from that described since heating is required to extract the fat. The time per test will consequently be longer and greater care is needed to ensure adequate extraction of fat.

Mincing has the disadvantage that fat tends to be left behind in the barrel of the mincer.

GENERAL

If any Works is interested in using the Refractometer technique, they are invited to contact the Meat Research Laboratory to arrange a demonstration or to have any queries answered.

Graph relating refractive index of ortho dichlorobenzene solution at 40°c to % fat in beef samples. (Works should carry out their own calibrations)



NEWS JOTTINGS:

Next issue will be Tenderising of Meat by Ageing.

The Meat Research Laboratory now has a staff of 64 including 25 graduates.

It is pleasing to note that the Laboratories are attracting many visitors. During February we had visits from the Hon. Malcolm Fraser, Minister for Education and Science, and from Lord Trenchard, Chairman of Walls Meat Group Ltd.

MEAT RESEARCH NEWS LETTER

CSIRO

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MEAT RESEARCH LABORATORY

P.O. BOX 12 (CNR CREEK AND WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170 TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

FRESH MEAT COLOUR

The most important single factor in the appeal of lean meat is colour. This is particularly true for consumers buying pre-packaged meat.

The appearance of the meat to the consumer depends on the type and quantity of the pigment present and on the physical condition of other components of the meat.

Myoglobin is a muscle pigment and normally constitutes about 80% of the pigments whilst the blood pigment, haemoglobin, constitutes about 20% of the pigments. The reactions undergone by these pigments in colour change are identical but, because of the relative quantities, myoglobin is the more important.

FACTORS DETERMINING COLOUR

1. Chemical Nature of Myoglobin

Most of the differences in the colour of meat surfaces arise from the chemical nature of the pigment.

There are three forms of the pigment:

(a) purplish red reduced myoglobin

(b) bright red oxymyoglobin

(c) brown metmyoglobin

The total effect seen by the consumer depends partly on the oxymyoglobin on or near the surface, partly on metmyoglobin just inside the surface and partly on reduced myoglobin remaining unchanged at these or greater depths.

In fresh meat, the most important chemical form is oxymyoglobin. Although it occurs only on the surface of the meat, this pigment represents the bright red colour desired by the consumer.

In meat that is newly cut, the reduced myoglobin pigment predominates. Very quickly oxygen diffuses inwards a short distance from the meat surface exposed to air and the bright red oxymyoglobin is formed. The colour of meat is brighter at low storage temperatures just above 29°F because oxygen is able to move to a greater depth, thus the depth of this bright red layer is greater.

Because the bright red colour of oxymyoglobin is desirable, most prepacked meat is placed in an oxygen permeable wrap (cellophane or polythene) and sealed. The wrap allows passage of oxygen but prevents undesirable drying out. Temperatures are kept as low as possible to produce maximum development of oxymyoglobin.

Patented spray or dip solutions are available to stabilise the desirable colour but little is known of their effectiveness.

Undesirable brown discolouration in fresh meat is predominantly caused by oxidation of the myoglobins to metmyoglobin.

The formation of metmyoglobin is highest at low oxygen levels, i.e. at lower levels than that required to form oxymyoglobin. The thin layer of brown metmyoglobin is formed a little below the meat surface, when stored in air, for this reason. Storage conditions which cause drying out of the meat surface may also promote metmyoglobin formation.

If the meat is vacuum packed in oxygen impermeable films, the meat and bacteria will use up the oxygen and the final oxygen level will normally be around 1%. At 1% oxygen the formation of brown metmyoglobin is maximal, being 2-3 times the amount formed in air (air has approximately 21% oxygen). Some methods of controlled atmosphere storage maintain the oxygen concentration above 5% or attempt to keep the oxygen concentration below 0.1% to limit the undesirable metmyoglobin formation between these levels.

If the meat is packed quickly while the pigment is in the purple myoglobin form, then on opening to air the bright red oxymyoglobin would quickly form. Once produced, the brown metmyoglobin is very stable.

2. Quantity of Myoglobin

The greater the concentration of myoglobin then the darker the meat.

A high level of muscular activity gives rise to more myoglobin. The colour also varies due to species, breed, sex, age and type of muscle. Thus, old bulls have more myoglobin than cows and steers, and calves have the least amount of pigment.

If chilled or frozen meat is allowed to lose moisture or dry out, then this will result in concentration of the pigment and contribute to a darkening effect.

3. The Effect of Light and Meat Texture

Examples of this physical effect are:

(a) when the surface of meat dries out, the way the light is reflected and absorbed gives a dark appearance;

(b) slow freezing gives large ice crystals which cause the light to be reflected and absorbed in such a way that a dark appearance is given. Rapid freezing results in small crystals and the colour is lighter;

(c) meat illuminated with red light will reflect more red than meat stored in white light and thus appear redder to an observer;

(d) visible light, especially light of short wave length (ultra violet), will speed up metmyoglobin formation in meat. The greater the intensity the greater will be the formation.

4. Bacterial Growth

If the environment is right, certain bacteria may grow on the surface of the meat, causing a discolouration, e.g. some strains of Pseudomonas can produce hydrogen sulphide when the oxygen and acidity levels are low. The hydrogen sulphide reacts with myoglobin to form sulphmyoglobin which is green.

5. Acidity of Meat

Dark cutting beef is caused by low acidity of the tissue.

At low acid levels in the meat there is also less oxymyoglobin formation at the surface so that the reduced myoglobin under the surface gives a dark appearance to the meat.

RECOMMENDATIONS

To obtain maximum colour appeal of packaged meats, the following procedures should be used:

(i) For fresh meat packaging in air permeable films: Use low temperatures (and if freezing, freeze quickly), seal the film to guard against moisture loss. Use conditions of atmosphere in which oxygen is above 5% and films of high oxygen permeability. There are now available grades of non-fogging permeable films which prevent condensation of moisture on the inner surface of the film.

(ii) For fresh meat packaging in air impermeable films which retard spoilage due to bacterial growth and surface oxidation: Pack the meat as soon as possible after cutting, use low temperatures and freeze quickly if freezing, check seals. If practicable use atmospheres in which the oxygen is less than 0.1% or greater than 5% (allowing for the usage of oxygen by meat and bacteria in the pack).

Under these conditions, colour stability will be limited by bacterial growth and spoilage.

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NEWS JOTTINGS

Next Issue will be Weight Loss on Holding Live Animals.

The building of the second stage of the Laboratory was completed last month. The new Cold Rooms, are expected to be completed and tested this month.

Some Works in Queensland are experiencing "dark cutting beef" in cattle from some areas. This is due to drought conditions which tend to reduce the energy reserved, or glycogen, of cattle. Cold conditions, lengthy transport time and harsh handling will accelerate this condition. On slaughtering there is not sufficient glycogen to produce the natural acid and a dark appearance will result from low acidity (pH above 6).

MEAT RESEARCH NEWS LETTER

CSIRO

NUMBER 69/6

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MEAT RESEARCH LABORATORY

P.O. BOX 12. (CNR. CREEK AND WYNNUM ROADS), CANNON HILL, BRISBANE, QLD 4170. TELEPHONE 95 4006. TELEGRAMS FOODPRES BRISBANE

MICROBIOLOGICAL CRITERIA FOR MEATS

There have been a number of statements in recent months referring to proposals to introduce in the United States microbiological standards for certain foods including some meat products. As the U.S.A. is an important market for Australian export meats there is obvious interest in the extent to which any standards introduced in the United States would affect products exported from Australia. The following notes may help to inform management in the Australian industry of the present position regarding standards and other microbiological criteria for foods.

A number of international and national committees have been investigating the problem of microbiological criteria for foods for some years. Further impetus has been given by the recognition that food poisoning outbreaks can occur on a large scale with modern conditions of manufacture and distribution of huge quantities of food.

The aim of microbiological criteria for foods is to protect the public by using objective methods of evaluating the bacterial status of the food. We are all familiar with microbiological standards for water and milk which have helped protect the consumer from disease from these sources.

Microbiological criteria may be based on tests for bacteria, fungi, yeasts or viruses. With meat, the usual organisms tested are the food poisoning and the food spoilage bacteria. Some bacteria are a distinct health hazard, e.g. Salmonella; others indicate a potential hazard, e.g. coliforms or Escherichia coli. Tests to indicate the total number of bacteria may reflect the conditions of production and storage.

There are three types of microbiological criteria:-

(1) Microbiological specification: The maximum number of a particular type of micro-organism allowed is specified, e.g. a Company's buying or selling specification.

(2) Recommended microbiological limit: A suggestion or a guide line is given within which it is suggested that industry should operate. This microbiological limit must be attainable under good commercial practice and can give warning of unsatisfactory conditions. There are already microbiological limits on 59 food products coming under the jurisdiction of the U.S. Food and Drug Administration.

(3) Microbiological standard: This is part of a law, or administrative regulation, and designates the maximum acceptable number of micro-organisms, or of specific types of micro-organisms, that may be present in a food. Those products which meet the standard are judged to be satisfactory for human consumption, while those products which do not meet the standard may be subject to seizure, condemnation or destruction.

For all three criteria there is need for clear statements on the following:-

(a) The method of taking samples and the number of samples to be examined.

(b) Detailed methods of analysis. Sometimes this is done by referring to published standard or official methods for the examination of the product. Such things as size of sample, method of preparation of dilutions in sterile fluid, the medium for growing the micro-organisms and the temperature and duration of incubation need to be specified.

(c) A clear method of interpretation. For example, the conditions under which a consignment will be accepted or rejected must be clearly stated.

Microbiological criteria for a particular product may refer to more than one type of organism. For example - a specification for a particular ready to eat meat product may include:-

Total plate count - not greater than 100,000/gram
Coliform bacteria - not greater than 100/gram
Salmonella - not present in 50 g

Acceptance of the product may depend on meeting all three specifications.

The choice of numerical limits is a matter of great difficulty, and must have regard to feasibility under commercial conditions. There is no point in setting numerical standards at low levels which industry is unable to meet, or at high levels attained only under unsanitary conditions.

Statements by officials of the United States Department of Agriculture have made it clear that standards must be related to good sanitary practice. The U.S.D.A. has, therefore, commenced detailed studies of the bacteriological status of some meat products at various stages of manufacture. Products now being studied include fresh sausage and some cooked cured meats, and it is in respect of such items that standards may first be introduced. Action on these products may result within the next year or two. U.S.D.A. officials have also indicated that when standards are introduced for domestic meat products, the same standards will apply to imported products of the same type.

For primal cuts and boneless meats in large pieces, sampling problems would be considerable, and five to ten years may elapse before standards for these products were considered. On the other hand, importers of meat from Australia could at any time introduce bacteriological specifications for imported products, including those being used in manufactured meats. It is not possible to state how likely this is, but manufacturers are certainly going to take an interest in the bacteriological status of the ingredients they are using. They may well seek to transfer the problems by writing bacteriological specifications for items being purchased.

CONCLUSION:

There is little doubt that microbiological specifications for some meat products will be introduced while most of our present Works' Managers are still in office.

At present there is considerable study of the microbiology of meat products by both Government and industry bodies in the U.S.A., and this is likely to stimulate further activity elsewhere.

Some official U.S.D.A. standards are likely to be introduced within the next three years for a limited range of manufactured meat products.

For ingredients of manufactured meats the introduction of official standards may be delayed, but importers may begin to write microbiological specifications at a comparatively early date.

Production of frozen meats with a consistently acceptable bacteriological status should not be difficult for Australian meatworks exercising proper control over the conditions of preparation and holding prior to freezing. The degree of control required may, however, be greater than has previously been attained in some plants.

* * *

Enquiries are invited from any Australian Works requiring further information, or advice regarding products for which a microbiological limit or specification has been requested.

JOTTINGS:

During June, we were visited by Mr. M. Honda, Secretary General of the Japan Meat Conference, and Mr. L. Mukai of the Foreign Trade Department. Mr. Honda showed considerable interest in chilled and aged meat.

Results of a recent experiment at the Meat Research Laboratory on ageing of cuts in controlled atmospheres showed significant increases in tenderness during the third week of ageing at 35°F. Based on taste panel results, the average increase in tenderness in the first two weeks varied between 19% and 71% depending on the meat cut. In the third week, the increase in tenderness was less and varied between 8% and 19% depending on the cut.

During investigations into Salmonella infection of sheep at slaughter, a new type of Salmonella was isolated at the Meat Research Laboratory, Cannon Hill. This has been confirmed by the International Salmonella Center, Paris, and has been named Salmonella cannon hill

Research into Drying Sheepskins:

The CSIRO Division of Protein Chemistry has been investigating the controlled drying of sheepskins. Dr. J.R. Yates of the Division is the scientist concerned.

In a paper published in 1968, Dr. Yates concludes:-

> "The practical possibility of a controlled system for the drying of sheepskins has been demonstrated. The system gives predictable drying in 48 hours without any deleterious effect on the skins. Processing trials have shown that the skins dried in this system are perfectly satisfactory, and superior in some respects to the normal skins of commerce.
>
> The conditions used in the drying system are a temperature of 27° to 29°C. (80°-85°F.) and an air velocity over the skin surface of 50-100 f.p.m. over the whole drying cycle. For the first 24 hours of the cycle, the humidity is kept as low as possible by using a 100 percent supply of fresh air. For the second 24 hours, the relative humidity is controlled at the 50-55 percent level in order that the final regain of the skins will be acceptable. This may be achieved either by regulating the supply of outside air and return air, or by steam injection if necessary. It has been shown that high temperatures *per se* do not have any deleterious effects on the skin quality, but damaging secondary effects preclude their use on a commercial scale. The presence of fat on the skins greatly increases the difficulties associated with the drying process.
>
> The use of thin U-shaped wire clips to straighten out the folds in the skin has been found to solve the problem of incomplete drying in the folds, which is potentially very dangerous."

Dr. Yates would be pleased to assist anyone interested further.

NEXT ISSUE of the News Letter will be Tenderising Meat using Enzymes.

MEAT RESEARCH NEWS LETTER

CSIRO

NUMBER 69/7

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MEAT RESEARCH LABORATORY

P.O. BOX 12. (CNR. CREEK AND WYNNUM ROADS), CANNON HILL, BRISBANE, Q D. 4170. TELEPHONE 95 4006. TELEGRAMS FOODPRES BRISBANE

TENDERISING MEAT USING ENZYMES

Some markets allow the use of proteolytic enzymes to tenderise meat. Although the end result is much the same as in ageing, the action of the added enzyme is believed to be slightly different.

Regulations concerning the use of enzymes differ from country to country and intending users are advised to check the market requirements. In many instances clients specify their own formula.

United States authorities have approved a number of enzymes for use in tenderising meat providing they do not result in a gain of more than 3% above the weight of the untreated product. In Australia, the Food Standards Committee of the National Health and Medical Research Council are currently considering standards.

TYPES:

Commercially used enzymes can be divided into three groups:-

(i) Those derived from either bacteria or fungi. These act primarily on the muscle fibre proteins and only have slight action on connective tissue proteins.

(ii) Those derived from tropical plants. Papain from paw paw, bromelin from pineapple and ficin from fig. These act primarily on the connective tissue fibre proteins although they also attack the muscle fibre proteins to a varying degree. For this reason these enzymes would be thought to be better for cuts containing large proportions of connective tissue, e.g. chuck, blades, silversides.

(iii) Those derived from animals, e.g. Trypsin from pancreas gland.

MEAT RESEARCH NEWS LETTER

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MEAT RESEARCH LABORATORY

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The tenderising action of enzymes takes place mainly over the cooking temperature range. There is practically no activity at refrigeration temperatures of storage so that enzyme treated meat can be kept below 45°F before or after cooking.

Optimum temperature of activity varies from enzyme to enzyme. Bromelin is most active at about 125°F and is inactivated at over 160°F.

Papain is most active at about 135°F and is still active after the final cooking temperature (over 170°F) has been reached. For this reason, meat tenderised with papain will continue tenderising if the product is kept warm, or reheated or recooked after processing. If any of these conditions are to apply, the enzyme strength must be adjusted. On the other hand, very little tenderising occurs during lower handling temperatures (under 80°F), and this relative safety of papain makes it suitable for some uses.

The microbial proteases have the advantage of rapidly and completely losing their activity at temperatures above 140°F. However, prior to cooking, they are relatively active at temperatures above 70°F.

Because of the different methods of action, a combination of plant, bacterial and fungal enzymes might function more efficiently in a tenderising formula than a single enzyme.

CONCENTRATIONS:

Enzymes are readily available from chemical firms servicing the meat industry.

For frying or grilling steaks, the following maximal concentrations of some commercially available enzymes were found to be satisfactory:

(i)	HT Proteolytic conc.	0.04% solution
	Protease M60	0.06%
	HT Proteolytic 200	0.10%
(ii)	Papain	0.02%
	Bromelin	0.035%

The level of enzyme to give desirable uniform tenderness differs from cut to cut and from grade to grade depending on the initial level of tenderness.

Cooking time and temperature also determines the concentration to be used. A roast that is going to take five times longer than a grill to cook, will need about one fifth of the concentration of the same enzyme to achieve a similar degree of tenderisation. Tenderised cuts require less cooking time than non-tenderised meat and there is less cooking weight loss.

Salts have a tenderising action on meat and 1½ - 2% of sodium chloride can be added to an enzyme solution with beneficial results.

STANDARDISATION:

The optimum level of an enzyme preparation to be used is determined by taste evaluation of the treated steaks. As a quality control measure, this desirable level of the particular enzyme preparation is standardised on an activity basis from one batch to another.

Standardisation involves an accurate assessment of the proteolytic activity of the enzyme on a standard protein at a fixed temperature for a fixed period of time by one or more of the available methods. Cost per unit of activity is an important factor when deciding which enzyme to use.

The proteolytic enzymes used for tenderising meat all show very good stability in the dry state though their activity may decrease after long periods of storage. In solution however, some of them lose their activity fairly rapidly. The use of solutions made up daily and kept under refrigeration is therefore recommended.

INJECTION METHODS:

There are problems of effectively introducing enzymes into raw meat to get uniform distribution of the correct amount of the enzyme.

A number of methods have been devised:

(i) Enzymes were first used as dips. As such they were unsatisfactory since they overtenderised the surface, producing a mushy texture.

Sufficient penetration and diffusion can be achieved in an individual steak by forking it (or pressing it against a plate supporting numerous small needles) while immersed in an enzyme solution and soaking for about 20 minutes. This method is suitable for housewives wishing to tenderise steaks.

(ii) A patented technique whereby the enzyme solution is injected into the animal prior to slaughter. The animal's own circulatory system distributes the enzyme throughout the carcase. The muscles in the carcase contain about the same concentration of enzyme (although there is some suggestion that the more active muscles get more) and the meat is therefore suitable for only one method of cooking. There is also an accumulation of enzyme in certain organs, e.g., liver, kidney, tongue, making them disintegrate on cooking.

(iii) Post-mortem pre-rigor pumping of dressed carcases. This may be done either by intravenous injection (where a solution retention of about 10% is necessary to get even penetration, or by intra-muscular injection using a series of needles where distribution is by diffusion through the muscle.

(iv) Conventional needle injection of cuts using single or multi-needle pumps. The larger the injection volume the faster the distribution in the meat.

(v) A patented method of supplementing the needle injection with controlled gas diffusion which permits proper penetration and diffusion of the enzyme solution.

A set of needles descends into the meat. On the downstroke nitrogen is emitted from the hollow needles and this opens the meat tissue. Then, on the upstroke, the enzyme solution atomised by the gas, enters the meat and is uniformly distributed.

A large proportion of the above has been derived from an unpublished report by P.E. Bouton, of this Laboratory.

JOTTINGS:

The Australian Meat Board held its August Meeting in the Laboratory's Conference Room.

Spray Washing of Carcases:

Some works still have difficulty with keeping quality of carcases washed with water.

It is generally accepted within Industry that spray temperature should be at least blood heat (100°F) to remove visual contamination. In the range of temperatures acceptable to continual handling, there is no advantage, from a keeping quality point of view, in choosing a higher temperature.

Although high wash pressures are useful in removing visual dirt, the higher the pressure the more likely that water will be imbedded in tissues; this may make it difficult to remove during chilling.

The problem of keeping quality of washed carcases against that of unwashed or wiped carcases is basically one of ensuring that refrigeration is adequate both to chill the carcase and remove excess surface water early in the chilling stage. Bacteria grow on wet surfaces, therefore it is necessary to suffer some weight loss to give keeping quality.

(i) Ensure that carcases are well spaced (not touching).

(ii) Apply cold temperatures with high air velocities as early as possible in the chilling stage.

(iii) Reduce running of hot carcases in with cold carcases to a minimum. Keep doors closed when not in use.

(iv) Ensure that the refrigeration design is adequate to cope with the removal of the excess water vapour.

NEXT ISSUE will be Salmonellae.

NEWS LETTER

MEAT RESEARCH NEWS LETTER

CSIRO

NUMBER 69/9

DATE 29th October, 1969

MEAT RESEARCH LABORATORY

P.O. BOX 12. (CNR. CREEK AND WYNNUM ROADS). CANNON HILL. BRISBANE. QLD 4170 TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

ECCHYMOSIS OR BLOOD SPLASH

Ecchymosis, or blood splash, is an escape of red blood cells from blood vessels into the surrounding muscle. The haemorrhage may result from rupture of blood vessels, usually very small ones (capillaries), or sometimes from leakage of red blood cells through small holes in imperfect blood vessels. In fresh meat the haemorrhages appear as dark red spots usually not more than ½" in diameter.

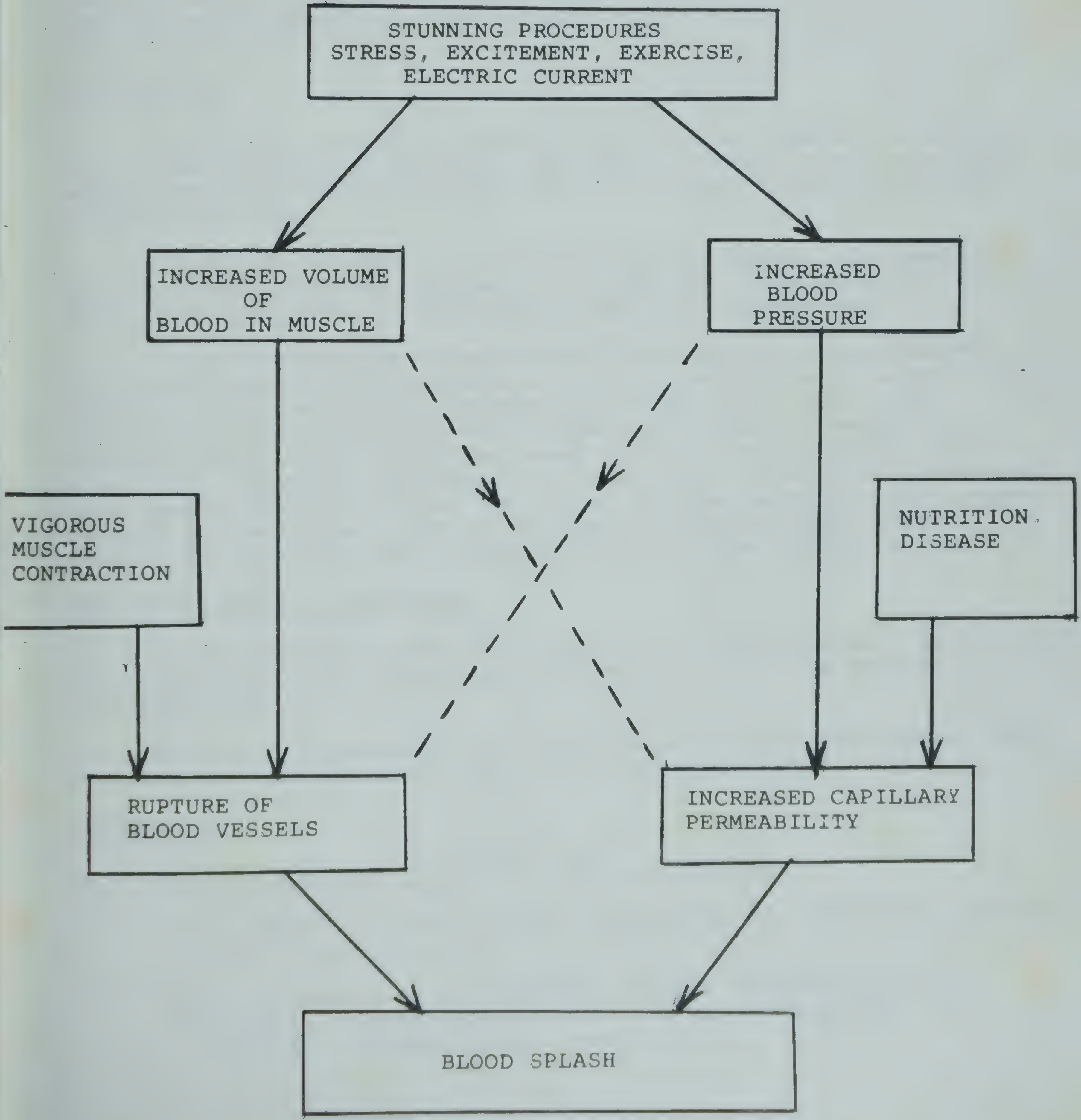
CAUSES OF ECCHYMOSIS:

The exact cause of ecchymosis is not known but it involves high pressures in the vessels, or weak blood vessels, or a combination of the two.

Preslaughter excitement and stresses lead to a general increase in blood pressure in the larger blood vessels and an increase in the amount of blood in the smaller vessels. At stunning, the blood pressure and heart rate increase. It is probable that rupture of the distended smaller blood vessels is caused by vigorous muscular contractions and struggling which occur after stunning.

Some diseases may weaken the vessel walls and result in an increased occurence of haemorrhages.

FACTORS WHICH MAY BE INVOLVED IN THE PRODUCTION OF "BLOOD SPLASH"



Climatic conditions appear to influence the incidence of the disorder. There is evidence that ecchymosis is more prevalent in the northern areas of Australia, but it is not confined to warmer areas. In one study, it was found that the incidence increased as mean daily temperatures increased. At certain times, particularly in the northern areas of Australia, up to 25% of cattle forequarters have been affected sufficiently to be downgraded.

OCCURRENCE:

Ecchymosis occurs throughout the world in cattle, sheep and pigs that are stunned prior to slaughter. It may occur in animals which have been bled without stunning but there is no documented evidence on this.

Almost any muscle can be affected. In cattle, the muscles of the forequarter are more severely affected than those of the hind, and ecchymosis is frequently seen in the diaphragm.

In electrically stunned animals, up to 66% of lamb hearts have shown some blood splashes and up to 20% of sheep hearts. The proportion of lamb hearts condemned because of this disorder may be up to 5%. The maximum incidence of affected hearts is usually found in the first few weeks after installation of the electrical stunning apparatus. However, even after works personnel have become used to methods of operation, the percentage of hearts showing at least one blood splash may average as high as 20%, with up to 2% being sufficiently affected to be condemned.

WHY IS ECCHYMOSIS IMPORTANT:

Economic losses result from meat being downgraded. Occasionally, the extent of blood splash may be sufficient for the product to be condemned.

Meat with blood splashes is unattractive in appearance. The splashes are particularly obvious in cured products.

PREVENTION:

(i) Animals that are "knocked" before bleeding:

(a) It is important that animals should not be excited or stressed before stunning.

(b) Bleeding should be carried out as soon as possible after stunning. Animals should be bled in turn and not left in groups, unbled, after stunning.

(c) In cattle, effective "pithing" (i.e. complete cutting of the spinal cord immediately after stunning) reduces the disorder to a very low incidence.

(ii) Animals that are electrically stunned:

(a) Animals should not be allowed to remain in the restraining race for long periods, and should be stunned at an even rate.

(b) The lowest voltage found to give satisfactory stunning should be used, particularly for lambs and other young animals.

The voltage and the time of application needed for young animals is less than that needed for older animals. Voltage and time settings are also affected by factors such as the length of the fleece, amount of moisture on the skin or hide in contact with the electrodes, and the type of machine in use.

(c) The points of the electrodes should be kept clean and sharpened regularly.

(d) The animals should be bled immediately after stunning. There is evidence that, with pigs, the interval between stunning and bleeding should not exceed five seconds.

FURTHER INFORMATION REQUIRED:

Any industry information relating to the incidence or occurrence of ecchymosis and any results of tests concerning ecchymosis, would be very useful to this Laboratory.

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NEWS JOTTINGS:

During October, we were visited by the fifteen members of the Australian Meat Industry Study Group from Japan.

Next issue will be Dark Cutting Beef.

MEAT RESEARCH NEWS LETTER

CSIRO

NUMBER 69/8

DATE 30th September, 1969

MEAT RESEARCH LABORATORY

P.O. BOX 12. (CNR. CREEK AND WYNNUM ROADS). CANNON HILL, BRISBANE. QLD. 4170. TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

SALMONELLAE

Some Background Information on Sources and Significance.

WHAT ARE THEY?

Salmonellae are rod shaped bacteria which were named after Dr. D.E. Salmon, an American Veterinarian, who first isolated them from diseased pigs in 1885.

Salmonellae can cause disease in both man and animal. In man, salmonellae, when ingested in sufficient numbers, cause food poisoning with symptoms of nausea, diarrhea, vomiting, and a mild fever.

There are over 1300 known types of Salmonellae which are distinguished from each other by small chemical differences in their surface structures. Serological methods are used to detect these differences, and so different types are referred to as serotypes. A serotype is defined by a particular combination of the surface structures. Interbreeding by salmonellae can give rise to new combinations thus giving new serotypes.

The convention adopted for naming these 1300 serotypes is to name them after the city, town or suburb in which they were first found e.g., S. adelaide, S. brisbane, and S. cannonhill.

The most common serotype is *S. typhimurium*. It was so named because it was isolated as the cause of *mouse typhoid*. In fact, *S. typhimurium* was once used as a commercial preparation to control plagues of rats and mice.

The frequency with which different serotypes are found varies in different countries, and at different times. For instance, *S. dublin* is commonly isolated from cattle in the U.K. and Europe but is very rare in Australia.

WHY ARE SALMONELLAE IMPORTANT?

One might well ask why there is the present world-wide concern with salmonellae, when presumably salmonellae have been with us since prehistoric time.

The first proven outbreak of salmonella food poisoning occurred in 1888 in Germany when 58 persons became ill after eating beef.

Since that time interest and awareness of the problem of salmonella food poisoning has gradually increased.

Initially most of the problem was thought to be related to diseased animals that were "emergency slaughtered". However, it soon became obvious that a wide variety of foods derived from apparently healthy animals could contain salmonellae and cause illness. By about 1950 the list of incriminated foods included eggs, fish and seafoods, all types of meat (particularly chicken and pork), unpasteurized milk, and coconut. The present list of known products that may contain salmonellae is large and continues to increase e.g. dried milk, yeast, carmine dye, vitamins, pharmaceutical products of animal origin, cocoa and chocolate.

As more information has become available about the increasing magnitude and seriousness of the problem, Public Health authorities have become more concerned. For instance, in the United States there has been a 20 fold increase in known cases of human illness from 1942 to 1964, and it is now estimated that in the United States of America some 2,000,000 cases of human infection occur each year.

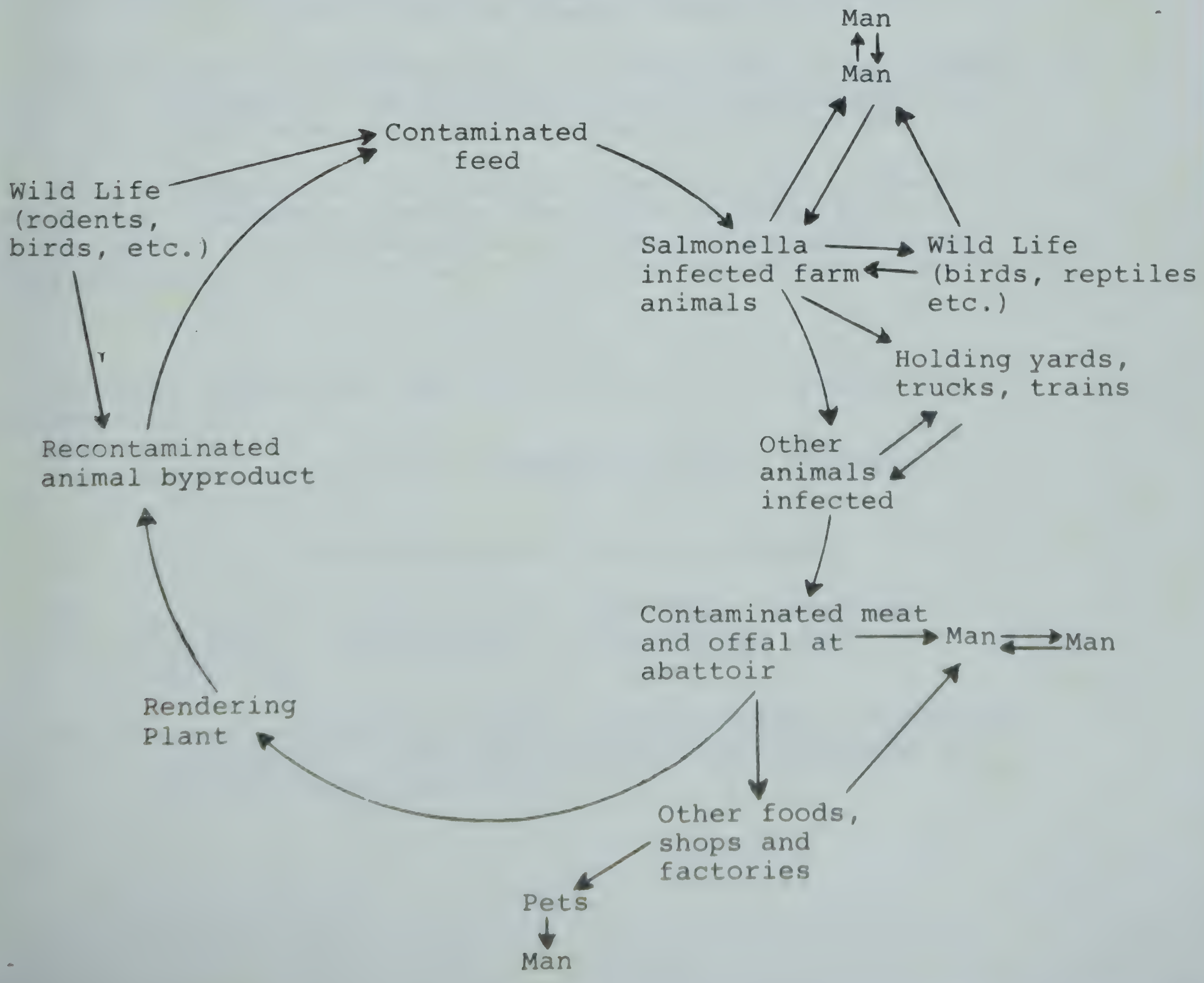
A report prepared in 1969 by a United States Committee on Salmonella (1) lists 8 factors that might be involved in the increased incidence of human illness. These include: changes in eating habits from home-prepared to communal meals (e.g. restaurants), mass production of processed foods with subsequent nationwide distribution, increased consumption of poultry and poultry products, increased number of products contaminated, and changes in food production methods that might allow better salmonella growth, or allow its growth without evidence of spoilage.

WHERE DO SALMONELLAE OCCUR?

While we think of salmonellae as normally belonging to the intestinal tract of men and animals, it is obvious from what has already been said that salmonellae can be found in a wide variety of products. As well as in human foods, salmonellae occur in animal feeds (such as meat and bone meal, fish meal and cottonseed cake), in the soil of saleyard and abattoir holding pens, in chicken litter, and in natural water supplies.

HOW ARE SALMONELLAE SPREAD?

There are many sources from which salmonellae can be spread to man and animals. The diagram below shows some of the interlocking cycles by which this can be done. Food products may be contaminated by the animal from which it is prepared, and by equipment, rodents, insects, dust and human carriers.



REQUIREMENTS FOR GROWTH:

Because salmonellae have simple nutritional requirements, and grow both in the presence and absence of oxygen, they can grow both inside animals and in moist environments outside animals (e.g. on food processing equipment).

Salmonellae can grow over a temperature range of 45° to 115°F. At body temperatures numbers may increase 1000 fold in only four hours. Growth can be prevented by holding products below 45°F. Salmonella can survive in frozen foods and growth will occur if the food returns to favourable temperatures.

CONTROL:

Present methods of salmonella control are imperfect in that:

(1) Raising and marketing animals under salmonella-free conditions is not at present feasible.

(2) Preventing contamination of foodstuffs is not always successful and multiplication of salmonellae can occur when the food is subsequently handled.

More effective control requires some terminal process to destroy the salmonellae such as canning or pasteurization. However, even such processes are not always successful since faulty processing and post pasteurization contamination can still occur.

The best advice that can be given in the preparation of boneless meat is:-

(1) Avoid, especially, contamination with intestinal material.

(2) Minimise contamination by hide, or fleece.

(3) Remove the possibility of salmonella growth on equipment, particularly in the boning room, by sanitation.

(4) Prevent salmonella growth on the product by adequate refrigeration during chilling and by holding at temperatures below 45°F.

POST-SCRIPT.

UNITED STATES SALMONELLA FOOD POISONING DUE TO IMPORTED BEEF.

The latest issue of Salmonella Surveillance (June 1969) reports an outbreak of food poisoning among 100 persons attending a wedding reception in Maryland, U.S.A., on June 14, 1969. The food concerned was boneless beef, which had been cooked in Washington D.C. on June 6, shipped to the caterer on June 13, sliced and taken to the banquet at 5.45 p.m. June 14, and served from 6 to 11 p.m.

S. welikada was isolated from the patients, the sliced beef, and several unopened packed roasts. This organism had not been isolated in the United States since the salmonella surveillance system started in 1962. It has been isolated in Australia on several occasions and it appears, therefore, that the meat may have been contaminated in Australia.

The report states there were a number of deficiencies in cooking and preparation. Production in the United States plant was stopped for a week while new processing procedures were developed.

References.

(1) An Evaluation of the Salmonella Problem, National Research Council, Washington - Committee on Salmonella - 1969 - approx. $5.00 U.S.

(2) Salmonella Surveillance (Report No. 87) U.S. Dept. of Health, Education and Welfare, June 1969.

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Next Issue will be Ecchymosis (Blood Splash).

MEAT RESEARCH NEWS LETTER

CSIRO

MEAT RESEARCH LABORATORY

NUMBER 69/10

DATE 28th November, 1969.

P O BOX 12 (CNR CREEK AND WYNNUM ROADS), CANNON HILL, BRISBANE, QLD 4170 TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

DARK CUTTING BEEF

Colour is an important factor in determining consumer acceptability of beef. Beef which is coloured dark red to dark purple is termed "dark-cutting". Since dark-cutting beef has a low acid content (i.e. high pH), the meat does not develop the normal bright red colour of oxymyoglobin (see News Letter 69/4). The meat appears dark because of a predominance of the purplish red pigment (reduced myoglobin) in the surface layer, and because less light is reflected from the surface.

IMPORTANCE

- Consumers do not like the appearance of dark beef. Some people associate a dark colour of beef with old animals or with meat that has deteriorated.
- Bacteria grow more rapidly on meat of high pH and therefore dark-cutting beef may have a reduced shelf life, at chiller temperatures, up to 50 percent less than for beef of low pH.
- High pH meat in packs which contain low oxygen (e.g. Cryovac) is susceptible to spoilage by bacteria which produce a light green pigment. For this reason, dark-cutting beef (pH above 6.0) should not be used for ageing in vacuum packs.

UTILISATION OF DARK-CUTTING MEAT

This meat should be used for outlets where a long shelf life at chiller temperatures is not required.

CAUSES OF DARK-CUTTING BEEF

The glycogen reserve in the muscle of a normally fed animal, handled carefully prior to slaughter, is about 1% of wet muscle weight. After slaughter, this glycogen is converted to lactic acid (about 0.7%) giving a pH of about 5.6 in the primal cuts at rigor mortis.

Dark-cutting beef results when there is a low muscle glycogen concentration (less than 0.5%) in the live animal at the time of slaughter. The amount of lactic acid production post mortem is less than about 0.5% and dark-cutting beef with a pH above 6.0 will occur.

CONDITIONS CONTRIBUTING TO LOW MUSCLE GLYCOGEN

- Sickness in animals, e.g. three day sickness.
- Animals that are exhausted or insufficiently rested prior to slaughter.
- Animals that have been exposed to cold, wet, windy weather. This effect could be greater in underfed animals, e.g. during the recent Queensland drought, the incidence of dark-cutting beef was particularly high in animals from drought areas that had just experienced a cold snap.
- Sudden withdrawal of feed after feeding on high energy rations.
- Animals that have been excited just prior to slaughter after a long period of transport.

The intensity and duration of the stress as well as the susceptibility of individual cattle to stress will determine the prevalence of dark-cutting carcases.

PREVENTIVE MEASURES

There is no easy measure known at present to prevent the incidence of dark-cutting beef. Care should be taken to avoid or minimise any of the above factors.

Resting and feeding cattle can reduce the incidence but the improvement in meat colour should be assessed against the cost of feeding and any loss of carcase weight which may occur.

MEAT RESEARCH NEWS LETTER

CSIRO

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MEAT RESEARCH LABORATORY

P.O. BOX 12 (CNR CREEK AND WYNNUM ROADS), CANNON HILL, BRISBANE, QLD 4170 TELEPHONE 95 ~~4006~~ 2122 TELEGRAMS ~~FOODPRES~~ FOODRESEARCH BRISBANE

CYSTICERCOSIS

Cysticercosis, the greatest single cause of rejection of Australian frozen boneless mutton in the United States Market, is a severe economic problem. It is also a cause for rejection or condemnation of mutton and lamb at Australian Abattoirs and the current Department of Primary Industry procedures are set out in CV circular 68/23.

WHAT IS CYSTICERCOSIS?

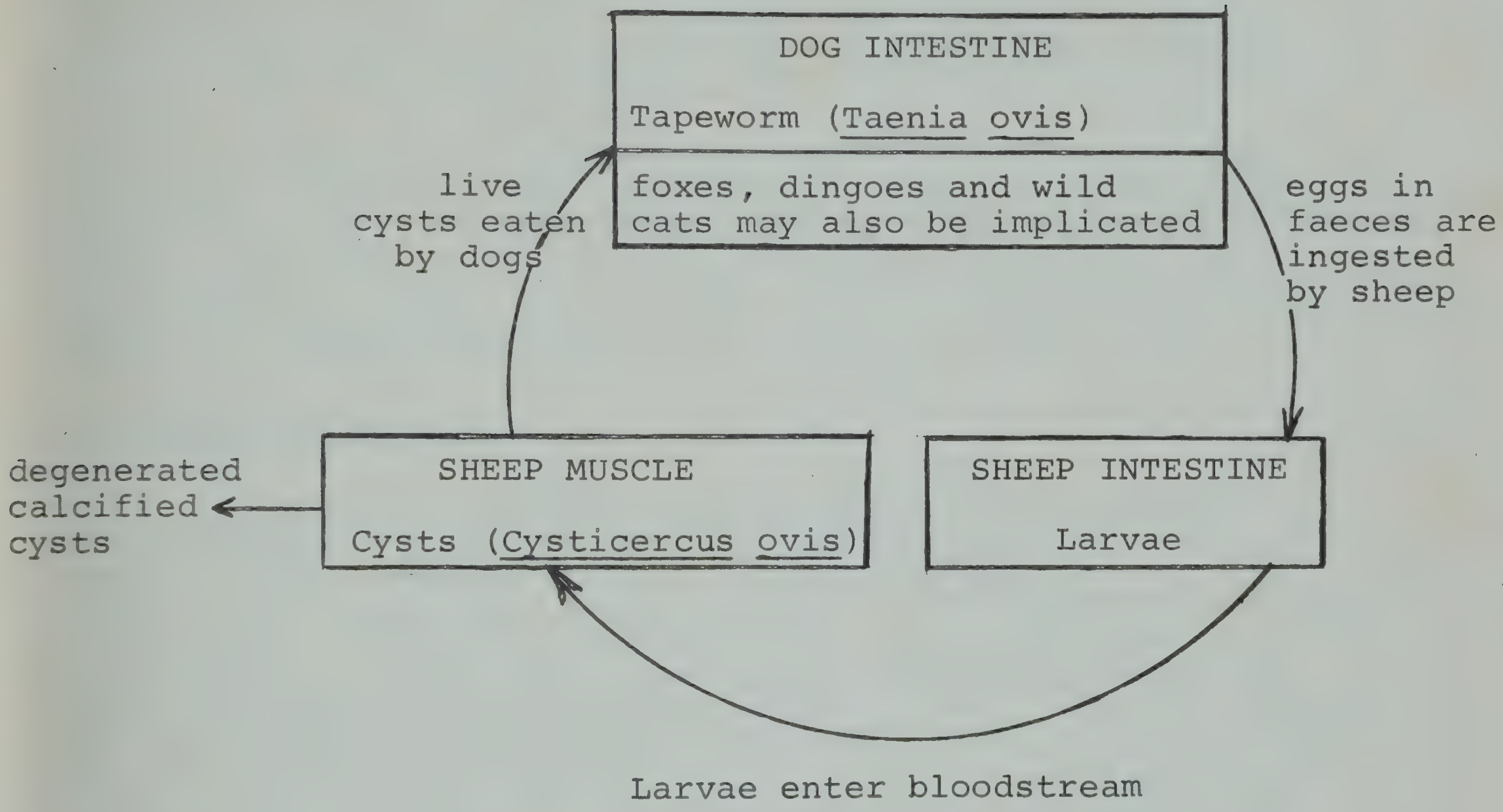
The condition of cysticercosis in sheep is primarily due to the presence of the cystic stage (*Cysticercus ovis*) of *Taenia ovis*, a tapeworm of dogs and foxes and, possibly, dingoes and wild cats.

Cysticercosis of sheep also includes *Cysticercus tenuicollis*, the intermediate stage of the bladder worm of dogs. In cattle, beef measles occur due to *Cysticercus bovis* which is the intermediate stage of the tapeworm of man. *Cysticercus cellulosae* is the cause of cysticercosis in the pig. Because of its importance, this News Letter will only be concerned with *Cysticercus ovis*.

Cysticercus ovis cysts can be found in the meat and offal of infected sheep and lambs. The fertile mature cyst is an egg shaped, thin walled fluid filled sac about 0.1" - 0.25" in diameter, containing a single tapeworm head. These live cysts are surrounded only by a thin fibrous wall and are therefore difficult to see in the tissues.

The degenerated calcified cysts are small, solid, white masses about 0.2" - 0.4" in diameter. These lumps, when scattered through the meat, give the condition the name "measles".

LIFE CYCLE



The tapeworm, *Taenia ovis*, is found in the small intestine of dogs. Eggs from the tapeworm are passed out to the pasture in faeces. When swallowed by a sheep, the eggs hatch in the sheeps intestine into larvae which penetrate the wall of the gut and enter a blood vessel.

The tiny worms are then carried in the blood stream until they lodge in a muscle where they grow into small cysts. Yellowish white lesions up to 0.1" long may be seen as early as 2 weeks after infection. It takes about 8 weeks for a cyst to develop to the stage of being infective to dogs. However, many of the cysts are destroyed by the host before fully developing, the degenerated centre becoming calcified and surrounded by a thick fibrous tissue capsule. With time the number of live cysts become less and most of the cysts have died and become calcified after 3 to 4 months.

The dog becomes infected with the tapeworm when it eats raw sheep meat or offal containing the live cysts. The single tapeworm head inside the cyst will develop into a large tapeworm in the dog's intestine in about 2 months (if a human ate a sheep measle cyst, nothing would happen!).

A tapeworm will live in a dog for up to about 9 months. Each worm is 3 to 4 feet long and divided into 200 - 300 segments. Each segment, when mature, contains about 20,000 eggs. A segment will break off and pass out of the dog in its droppings every 1 or 2 days. A dog carrying one tapeworm can, therefore, infect a lot of sheep but will usually show no outward symptoms.

REDUCING THE PROBLEM

The limited surveys of dog infestation in Victoria and Tasmania indicate an overall incidence of about 2%. The way to reduce the incidence of cysticercosis, in the long term, is to break the cycle by eliminating tapeworms in dogs. This can be achieved by ensuring that dogs do not eat raw sheep meat or offal and by obtaining veterinary advice on treatments to remove tapeworms from the dog. However, because of the possible involvement of the fox and dingo as hosts, it is not known by how much infection in sheep and lamb would be reduced if tapeworm infestations in domestic dogs were completely eliminated.

Individual sheep flocks show an infected carcase incidence as high as 20% - although the average figure is much lower, particularly with lambs. In the *short term* the problem of reducing or eliminating the incidence of cysts in the export packs can only be solved by improved methods of quality control in abattoirs. Better surveillance before or during packing of meat and offal may be necessary in some plants. X-ray examination enables calcified cysts to be detected and hence infected meat could be excluded from export using this technique.

Industrial X-ray equipment for displaying images of the cysts and other X-ray dense material is now being installed for testing at the Meat Research Laboratory. If results of these tests are satisfactory, the equipment will be used for production line testing in a meatworks preparing boneless mutton for export.

Next Issue will be Ultra-Violet (U.V.) Storage of Meat.

MEAT RESEARCH
NEWS LETTER

CSIRO
DIVISION OF FOOD PRESERVATION,
MEAT RESEARCH LABORATORY,
PO BOX 12 (CNR CREEK AND WYNNUM ROADS), CANNON HILL, BRISBANE, QLD 4170 TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

NUMBER 70/4
DATE 29th April, 1970

CLEANING AND SANITATION

All meat operations have at some time suffered losses of product through microbial spoilage. These losses can be total, in that the product has to be destroyed, or partial, in the acceptance of a reduced price or in reprocessing to an item of lesser value. These losses can be avoided or minimised by careful hygiene control of the handling and storage conditions, and by careful control of the storage times and temperatures (see News Letter 69/1).

There is an increasing emphasis on the bacteriological status of meat and meat products and a strong possibility of both governmental and private microbiological standards and guidelines being implemented. Because of this it is time managements examined their responsibilities in this area and reviewed their cleaning objectives.

Proper cleaning methods produce sanitary conditions which are a good investment resulting in:

- Extended storage life of both raw and processed meats,
- Production of conditions allowing inspections without risk of suspension on sanitation grounds, and of a product capable of meeting private and governmental microbiological specifications,
- Reduction in the risk of product being involved in outbreaks of food poisoning,
- Fewer product rejections, returns or complaints,
- Less need to reprocess product,
- Reduction in maintenance costs and time lost through breakdowns.

The control of the microbial populations on floors, walls, equipment and in the air needs the intelligent use of an appropriate cleaning programme.

WHAT IS A CLEANING PROGRAMME?

A cleaning programme is a planned schedule of how, when and where cleaning will be done. The schedule should include written instructions giving details of the frequency, the method, the strength and type of detergent to be used and any variations (e.g. acid detergents should be used at times), how to dismantle the equipment for cleaning, the sanitizing agent to be used, its strength and method of application, and variations in the type of sanitizer.

The cleaning programme should be under the control of a trained supervisor and copies of the schedule should be available to him and all key personnel. The necessary equipment should be readily available to the people performing the work. Careful control should be kept on the use of detergents and sanitizers - they should be purchased in bulk and distributed in smaller quantities to convenient locations throughout the plant.

If the current programme or system does not result in satisfactorily cleaned surfaces then a reassessment is needed - it could be that the procedures used in cleaning do not allow the detergent to perform its task <u>or</u> an alternative detergent material is needed.

The cleaning of a plant is expensive in terms of labour, water, steam and detergents and because of this it is important that it be closely supervised. The value of a correctly functioning cleaning programme cannot be over emphasized and managements should ensure that good supervisors and labour are available for this task, that the cleaning staff understands its functions and responsibilities, and that the methods of cleaning used are satisfactory.

SUGGESTED METHOD OF CLEANING

In reply to the question "How do you clean your plant?", all too often the reply is "With a hot water hose and water at 180°F.". Experience has shown that this method of cleaning does not achieve the desired result, and the microbial populations on surfaces treated this way are often excessively large. A suggested method of cleaning, found to give successful results, is listed below:

(i) <u>Dry Clean the entire area</u>. Sweep, pick up dropped meat and other material, and remove this to waste areas or bins. Scrape the fat from the surface of cutting boards, belts etc. and put the scraps in rendering bins.

Remove all plastic and other packaging material from the area. All moveable equipment (cutting boards, containers, etc.) should be taken away to be cleaned and treated as separate articles.

(2) Wet all equipment. Hose with low pressure water at a temperature less than 110°F. The purpose of this operation is to soften blood residues (if blood is hosed with hot water it is difficult to remove).

(3) Apply a suitable detergent. It is essential to use a suitable detergent to clean satisfactorily. The nature of meat residues to be removed makes it desirable to use mildly to highly alkaline detergents. Care should be exercised in the choice of detergents since some can cause corrosion of construction materials e.g. Aluminium, galvanizing. The method of application of detergent is variable. Where large areas are to be cleaned, the possibility of using foam cleaning should be examined. A sufficient time for the detergent to act must be allowed. Some mechanical action (e.g. scrubbing) may help considerably to speed this action. Temperature has an effect on detergents: efficiency increases with increasing temperature, but above 140°F the benefits are small and some detergents work effectively at lower temperatures.

(4) Rinse off Detergent. It is essential that the detergent and the residual material loosened by it be thoroughly rinsed off the surface. Failure to rinse sufficiently will allow a film to accumulate on the surfaces. Warm water at about 110°F is recommended although cooler water may be adequate.

(5) Apply a Sanitizer to All Surfaces. A sanitizer is a chemical which kills microorganisms. It can be used either combined with a detergent in step (3) or separately on the clean surfaces after rinsing off the detergent. As a separate operation it can be applied by spraying, flooding or by fogging the entire room. Acceptable materials used include chlorine (e.g. Sodium hypochlorite), quaternary ammonium compounds, iodophors, and complex phenolics. It is essential to allow at least 10 minutes for action of the sanitize which can be left on surfaces overnight.

(6) Hot Water Rinse. Rinse all surfaces with hot water at 180°F after the completion of sanitation or, if sanitizer is left in contact overnight, rinse contact surfaces before the commencement of work. This is important since there is a risk of taint by residues of some sanitizing materials.

No free water should be left on or in equipment or floors overnight. Equipment and floors should be self-draining.

Removeable equipment (cutting boards, trays etc.) is treated slightly differently:

(1) Dry clean.

(2) Hose with warm water.

(3) Immerse individually in hot water (130° - $140^{\circ}F$) containing a detergent or detergent-sanitizer. After soaking for 20 minutes, scrub all surfaces and rinse with clean warm water.

(4) If only a detergent is used in Step (3), then soak in a sanitizing solution for 20 minutes. Rinse with water ($180^{\circ}F$).

(5) Place each item in such a position that the surfaces are not touching - allow to air-dry. Do not stack polythene cutting boards on top of one another.

Polythene cutting boards can be significant sources of spoilage organisms when inadequately cleaned. Because of the nature of the scored surface they are difficult to clean and should be resurfaced every 2 - 3 weeks using a belt-sander. There is also a tendency for cutting boards to be physically too large to handle properly so their size should be kept to a minimum.

Excessive use of hot water in the areas to be cleaned can result in condensation forming on the overhead gear, ceilings, ductwork etc. The condensate falls on to the surface of equipment and product and depending on the cleanliness of the overhead gear can result in a clean surface becoming very dirty. It is necessary, therefore, for overhead areas to be cleaned on a regular basis to avoid contamination from this source.

The design of equipment and the materials used in its construction should facilitate cleaning. This is an important factor to consider in the purchase of equipment.

HOW CLEAN IS CLEAN?

It is essential that every surface touched by the product should be visually free of food particles, be free of chemical residues, and not have excessive microbial populations. A commercially-clean surface will not be sterile, but the number of organisms on a product contact surface should be much less than the number on the product passing over it. The surfaces should not add significant numbers of spoilage organisms to the product passing over it, and the total environment should not have any food poisoning organisms present.

All contact surfaces should be clean before meat is placed on them, but there will be an equilibration of the numbers between the surface and the meat so that after a period the work surface will carry a population determined by the numbers on the product passing over it, and any growth that occurs on the surface. Therefore, the process of cleaning and sanitation is to ensure that the "cleaned" work surface does not add organisms to an otherwise satisfactory product.

There are several tests which can be used to see if a surface is clean and these are:

- General appearance - Contamination or oxidation should not be visible under good lighting conditions. Particles of meat should not be present in the cleaned room.
- The work surfaces should not feel greasy or rough when rubbed with the fingers.
- A clean white tissue should not be discoloured when rubbed over the surface of cleaned stainless steel - this is not applicable to aluminium or galvanized material.
- No objectionable odour should be detected.
- All surfaces should be dry before work as a result of cleaning operations the previous night.
- When a cleaned surface is wetted, the surface should not show signs of excessive water breaks while water is passing over the surface.
- After cleaning and sanitizing, the work surfaces should have microbial populations below a maximum value, the value depending upon the product, its stage in processing and expected storage life.

The first six tests are quickly performed and can be done on a daily basis by a trained Quality Control Officer as a portion of the routine housekeeping inspection.

Since bacteria cannot be seen by the eye, visual inspections give little indication of the microbiological status of the surfaces. Therefore, some technique for checking the level of contamination is necessary. The techniques used are simple, and the necessary equipment is not expensive. Quality Control Officers can be taught these simple routines, and can then check the adequacy of cleaning and sanitation on a regular basis. The visual and microbiological inspections can assure that the methods of cleaning employed by your Organisation are effective.

Sanitation has been described as good housekeeping desired by management:-

Have you a cleaning program for your plant?

Is it adequate for your needs?

Do you receive regular reports that the program is being carried out thoroughly?

Is the standard of housekeeping in your plant equal to the standard in your home and to the standards expected by your customers?

If you answer "YES" to all the above questions, you should ask for a raise in your salary!

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NEWS JOTTINGS:

The subject of detergents, foams and foam guns is being investigated and a report will be made to industry later this year.

Supplies of a range of prepared medias and pre-poured petri dishes for use in bacteriological testing of equipment and meat can be obtained from: Bacto Laboratories Pty. Ltd., 18 a Moore Street, Liverpool, N.S.W., 2170, and Bio-Science Laboratories Pty. Ltd., P.O. Box 113, Glenroy, Victoria, 3046.

In May, 1970, the Hawkesbury Agricultural College is holding a Quality Control course sponsored by the Australian Meat Board. This course will include an introduction to microbiological quality control. If successful, it is hoped to hold another school later in the year.

Buffalo Meat: Taste panel tests on domesticated and rested wild Northern Territory Buffalo 1½ to 5½ years old showed that the fillet (tenderloin) was rated as tender, of a tenderness comparable to that of cattle, but striploins were considered tough.

NEXT NEWS LETTER:

The next News Letter will be:

Spoilage of Fresh Carcases - The Effect of Surface Drying.

MEAT RESEARCH NEWS LETTER

CSIRO

NUMBER 70/6

DIVISION OF FOOD PRESERVATION,

DATE 30th June, 1970.

MEAT RESEARCH LABORATORY,

PO BOX 12 (CNR CREEK AND WYNNUM ROADS) CANNON HILL, BRISBANE QLD 4170 TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

THE USE OF PACKAGING FILMS FOR CHILLED FRESH MEATS

Increased sales of packaged meats, together with the popularity of aged beef and the possibility of exporting chilled packaged meat, demand more of packaging as an aid to handling and distribution. The technical advantages of packaged meats are the preservation of appearance, flavour, moisture and, in some cases, an increase in shelf life.

PACKAGING MATERIALS

A large variety of packaging films is available and new types are constantly being developed. Selection of a particular type is based on the following main considerations bearing in mind the cost, the required storage life and the temperature of storage:-

GAS PERMEABILITY

Film materials differ widely in their gas permeability properties A rough classification of some films of comparable thicknesses can be made according to their oxygen permeabilities at high relative humidity levels.

High Permeability	Low Permeability
* Polyethylene	Polyamide (nylon)
Polyvinyl chloride	**** Polyester
Polystyrene	*** Vinylidene chloride-vinyl chloride copolymers
Regenerated cellulose (plain or coated with nitro cellulose)	Regenerated cellulose (coated with above copolymer)
Polypropylene	Aluminium foil laminates
** Rubber hydrochloride	

Where two or more films are combined by coating or laminating, the permeability of the combination is similar to that of the least permeable member.

The storage life of a package is related directly to the bacterial load at the time of packaging and the temperature conditions under which the product is held. The problems in packaging fresh meats are that of colour stability and bacterial spoilage and the requirements for the control of each are sometimes mutually incompatible:-

(i) PERMEABLE FILMS

Films with high permeability to oxygen are commonly used for short term storage where the most important consideration is appearance of the product.

Satisfactory development of the bright red colour (oxymyoglobin - refer News Letter 69/4) occurs at oxygen percentages comparable to that in air. This means that the higher the permeability of the films to oxygen, the better will be the colour of the meat.

Storage temperatures as close as possible to 29.5°F (but not below) are desirable to give maximum shelf life and optimum colour. Temperature should always be maintained below 45°F to prevent the growth of food poisoning organisms, such as Salmonella.

The shrink and stretch type films further improve package appearance by clinging closely to the products.

Films permit some loss of moisture by permeation but should be well sealed to guard against excessive moisture loss. Because of the reduction in surface moisture evaporation, bacteriological spoilage of these wrapped meats in air is likely to occur sooner than with unwrapped meats, where more weight loss is incurred. "Weep" will occur in any film and absorbent trays are commonly used to prevent free fluids from detracting from the appearance of packages.

* Such as the product sold under the name of "Polythene" and "Zendel" film.

** Such as the product sold under the name of "Pliofilm".

*** Such as "Cryovac S", a product of W.R. Grace and Co., "Glowrap Shrinkbags", supplied by Globus Casing Co. Pty. Ltd., and "Saran", a product of Dow Chemicals (Aust.) Ltd.

**** Such as "Mylar", a product of Dupont, and "Melinex", a product of I.C.I.A.N.Z. Ltd.

Extended storage life comparable to that of vacuum packed meats in impermeable bags can be achieved by controlled atmosphere storage in gas tight chillers using atmospheres of 25% carbon dioxide. In this atmosphere the red meat colour is fairly well maintained because the oxygen level is still relatively high. Above 5% oxygen no more surface browning occurs than that experienced in air.

(ii) IMPERMEABLE FILMS

Meat packaged in films of low oxygen and carbon dioxide permeability has extended storage life and the development of rancidity is inhibited.

The composition of the gaseous atmosphere inside an impermeable package determines, to a great extent, the storage life of the meat and reflects both the efficiency of the packaging process and the performance of the wrapping films. Perfect seals are essential and the lower the permeability of the film to gases, and the lower the oxygen concentration and higher the carbon dioxide concentration in the pack, the longer will be the storage life.

For maximum storage life, temperatures should be as close to 29.5°F as possible, and definitely not above 36°F.

Vacuum Packaging

Under the conditions of low oxygen percentage, the myoglobin in meat is in the reduced purple form and this colour at present has undesirable sales appeal. Although the bright red colour will return if the vacuum packaged cuts are opened, once opened the meat will only have a very limited storage life as the oxygen/carbon dioxide levels inhibitory to bacterial spoilage are lost.

Two types of vacuum packaging are used:

(a) Evacuation and Sealing without a Chamber.

Evacuation is performed via a tube. The vacuum produced is not as good as that achieved by the chamber system, the amount of oxygen usually falling to about 1 - 2% of the final gas composition.

However, the vacuum employed reduces the air content in the bag to a level such that the carbon dioxide subsequently released from the meat builds up to around 20% of the gas composition. It is this carbon dioxide build up in the bag which is important in retarding the growth of bacteria. Vacuum packaging should therefore be done within ½ hour of boning or cutting so that carbon dioxide is not lost to the air.

Due to the reduction in head space, and consequent higher carbon dioxide concentration, heat shrunk bags give a slightly longer storage life than non-shrink bags. At 30.5°F, meat in sealed bags will have a safe shelf life up to about 7 weeks. At 35°F, the meat would keep for about 5 weeks.

(b) Vacuum Sealed in a Chamber.

The package to be sealed is completely enclosed in a chamber, which is then evacuated and the package sealed prior to its release from the chamber. In this process, bacteria are retarded by the same action as above.

Reduction of oxygen concentration does not affect the normal spoilage organisms until its level falls below 0.8%. If a vacuum is such that the resulting oxygen level is less than 0.8%, this low oxygen content ensures better retardation of bacterial growth than evacuation without a chamber, where only the carbon dioxide has an inhibitory effect. At his oxygen level there will be less browning than produced in method (a), but to prevent any browning, oxygen levels of less than 0.2% are needed.

Gas Packaging

Either pre-made pouches or roll stock films are used. The package containing the meat is flushed with an inert gas to displace the air, and then sealed. A step involving evacuation may be used in conjunction with this gas flushing step. It is important that the operation takes place as quickly as possible after boning or cutting.

Two gases, or a mixture, are commonly used:

(a) High purity grade Nitrogen.

Flush with oxygen-free nitrogen to aim for a residual oxygen level in the pack of 0.2% or less. This will give storage life equivalent to about 25% carbon dioxide (i.e. up to about 6 weeks at 35°F). In this atmosphere there will be minimum browning and the meat is purple in colour but on exposure to air will return to its original red colour.

(b) Carbon dioxide.

Flush with 20% carbon dioxide in air to give about 20% carbon dioxide in the pack at the time of sealing. Within a short period this level can build up to 25 - 30%. Concentrations of carbon dioxide over 30% can cause a greyish discolouration of the meat and should be avoided.

(c) Combination of Nitrogen and Carbon Dioxide.

A suitable mixture is 20% carbon dioxide with 80% nitrogen. The flushing should aim to reduce the final oxygen level in the pack to 0.2% or less. Colour will be similar to (a) above, using Nitrogen.

With a residual oxygen level of 0.2%, this method will give longer storage life than the two previous methods because of the dual action of high carbon dioxide with low oxygen concentrations.

MOISTURE PERMEABILITY

Most films minimise evaporative weight loss. However, even in properly sealed bags some weight loss will occur, but this is less than 0.2% in 2 weeks and is not detectable on the common meatworks scales.

It is usual to select a film which is sufficiently permeable to moisture vapour to prevent unsightly condensation within the package, but not so permeable as to lead to excessive weight loss. Shrink and stretch films which cling tightly to the meat largely eliminate the condensation problem.

GENERAL

Packaging, properly used, opens up new sales outlets. However, the advantages of packaging will be lost if the product is not produced, transported and sold under proper conditions of sanitation and refrigeration. Enquiries on any aspect of this subject are welcome.

NEXT ISSUE will be:

"The Use of Films for Packaging Cured and Processed Meats".

MEAT RESEARCH NEWS LETTER

CSIRO

DIVISION OF FOOD PRESERVATION,

MEAT RESEARCH LABORATORY,

PO BOX 12 (CNR CREEK AND WYNNUM ROADS) CANNON HILL BRISBANE QLD 4170 TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

NUMBER 70/5

DATE 26th May, 1970.

SURFACE DRYING OF MEAT AND ITS EFFECT ON STORAGE LIFE OF CHILLED CARCASES

The storage life of meat is determined by the initial contamination it receives during slaughter and by the conditions under which it is chilled and stored after slaughter. Although care in holding of stock and in the procedures used in slaughtering, dressing and handling can minimise the initial contamination, this, unless controlled, will rapidly develop and result in a reduced storage life and ultimate spoilage of the carcase.

The rate at which the microorganisms grow depends largely on the temperature and moisture content of the surface where the organisms are located.

During chilling, provided adequate refrigeration has been applied, both temperature and moisture content of the surface tissues fall leading to a significant decline in the growth rate of microorganisms. Bacteria grow best on wet surfaces and removal of water will therefore inhibit the growth of organisms, but it also leads to shrinkage or weight loss. Consequently if it is desired to keep chilled carcases for a reasonable length of time, some weight loss has to be tolerated.

Investigations are now being made to obtain a better understanding of the interplay of cooling and evaporation during the chilling and storage process and some general principles can be stated:

EVAPORATION OF WATER FROM CARCASE SURFACE DURING CHILLING

The rate of drying of the carcase surface will depend on the differences between the rate of evaporation and the rate of diffusion of moisture from the deeper layers of tissue. This diffusion rate will depend on the proportion of tissue, muscle, fat or connective tissue in the carcase.

During chilling, the evaporation of water from the surface depends on:

(a) the supply of heat within the carcase, i.e. the temperature differences between the carcase surface and the surrounding air. Evaporation decreases markedly as the temperature of the meat surface and the air come closer together. Fast chilling with low air temperatures, compared to slow chilling, gives a faster rate of weight loss but, because of the shorter chilling time, produces a lower total weight loss. This of course is desirable from a weight loss point of view and air temperatures in chillers should be initially as low as possible without causing freezing of the carcase surface.

Because of the slower rate of cooling, it is not difficult to remove sufficient moisture from beef carcases. However, the surface temperature of lamb, mutton and calf carcases, and the thinner areas of any carcases, such as necks and flanks, comes down much more quickly and the water content is comparatively high in these areas. Spoilage difficulties are therefore more common in these meats. With these small carcases a high rate of drying must be obtained during the beginning of the chilling phase to remove the surface water. Once the surface temperature has come down to the air temperature, rapid removal of excess water is difficult under most plant conditions.

In experiments with beef sides, it has been shown that surface water content on the thick muscles around the aitch bone is always much lower than on the thin muscles of the neck and flank. In fact, the numbers of microorganisms on the aitch muscle area are often reduced during the first 10 hours of cooling. This is associated with slower cooling and fairly high surface meat temperatures which give rise to a high rate of drying.

(b) the drying power of the air, which depends on its temperature and relative humidity. The higher the relative humidity the less the weight loss. However, humidity has only a comparatively minor effect on the rate of evaporation in the earlier stages of chilling.

(c) the speed of air movement. A higher velocity will give rise to a faster cooling rate on the surface of the carcase. The overall effect of velocity is a very complex one and most workers

support the theory that high initial velocities followed by lower velocities in the later part of the chill give rise to a desirable fast initial rate of weight loss together with a low total weight loss.

Because of the speed at which the surface temperature drops in lamb and mutton (i.e. smaller carcases), a faster air speed is needed for these than for the larger beef sides.

(d) meat quality factors. Fat meat loses less weight than lean meat. Weight loss decreases with increased carcase weight (because of the decrease in surface area per unit weight). Carcases with large areas of cut surfaces have a high weight loss from the exposed muscles.

MICROBIAL GROWTH DURING STORAGE OR HOLDING OF CARCASES

During chilling the deeper tissues of meat attain a temperature close to that of the air in the chiller.

After this period the rates of evaporation fall to a very low level. When the rate of diffusion of water from the deep to the surface layers exceeds the rate of evaporation, the water content of the surface tissues will increase. Condensation from the air may also occur. However, microbial growth during this storage phase may be controlled by minimising the increase in surface water contents through the maintenance of sufficiently high drying power of the air. The drying power depends upon the relative humidity and air speed over the carcase surface. The difficulty is often to restrain excessive evaporation during storage and a relative humidity in the range 87% to 91% and air speeds of about 10ft/min at the surface are considered satisfactory. While polythene or stockinette bags will protect carcases from dirt and decrease weight loss, it should be remembered that these can lead to faster growth of bacteria and decreased storage life.

RECOMMENDATIONS:

1. Plan the operation of chilling and holding to ensure that the weight loss is no more than needed to give the desired storage life.

2. Remove water from the surface of the washed carcase as quickly as possible by either mechanical means or by evaporation:

(i) load promptly into chiller.

(ii) load carcases so that they are not touching and there is adequate air circulation between them. Where surfaces are in

contact, the air circulation is poor, and cooling and moisture removal slow. In a case examined recently after overnight chilling, moist areas in contact with each other had counts of 60 million to 600 million coliform organisms per square inch while non-touching drier areas only ½" away had only 60 to 600 per square inch.

(iii) *do not* put hot carcases in a chiller with partially chilled carcases. This would not only slow down chilling of the cold carcases but may also produce condensation of moisture on them. Keep the chiller closed to avoid entry of hot air which may condense on the carcases.

(iv) Apply *cold temperatures with high air velocities* as *early as possible* in the chilling stage, but ensure that the surfaces do not freeze. If practicable, *pre chill* the room to low temperatures before the commencement of loading.

(v) Ensure that the refrigeration design is *adequate* to cope with the removal of the excess water vapour.

3. When the surface temperature of the meat has dropped almost to the desired final carcase temperature, the *air velocity* should be *reduced* and the *relative humidity raised* slightly to produce conditions which keep evaporation as low as is consistent with the desired storage period. Remember that it is necessary to make a compromise between weight loss and keeping quality. Increasing the weight loss will retard microbial spoilage.

4. Keep *records* of temperatures in chillers and holding rooms and of weight losses during chilling and storage. Relate these results to the appearance and storage life of your product.

5. Ensure that the principles involved are understood by the appropriate staff and that your decisions based on these are consistently *carried out*.

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NEWS JOTTINGS:

As part of its research programme, the Meat Research Laboratory is studying aspects of the chilling process. Equipment has been developed for measuring histories of carcase weight and temperature, air temperature, relative humidity and velocity. This will permit collection of data in works chillers in a form suitable for computer processing. It is hoped that this information will lead to the design of better methods of chilling to reduce weight loss and retain satisfactory keeping quality, colour and tenderness.

REMOVING HAIRS FROM CARCASES

Industrial vacuum cleaners which remove hairs from cattle and calf carcases are available. The name of a firm which supplies vacuum equipment designed for the meat industry can be obtained by writing to the Meat Research Laboratory.

Next Issue will be The Use of Packaging Films.

MEAT RESEARCH NEWS LETTER

CSIRO

DIVISION OF FOOD PRESERVATION,

MEAT RESEARCH LABORATORY,

NUMBER 70/7

DATE 11th August, 1970

P.O. BOX 12. (CNR. CREEK & WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170 TELEPHONE 952122 TELEGRAMS FOODPRES BRISBANE

THE USE OF PACKAGING FILMS FOR CHILLED PROCESSED MEATS

As with fresh meat, the preservation of appearance in processed meats is of great importance to the consumer. Packaging protects product colour, and facilitates marketing by enabling brand selling of conveniently sized portions and, in some cases, by increasing storage life.

UNCOOKED CURED MEAT

In uncooked meats, the desirable attractive pink colour is susceptible to oxidation and is readily converted to the undesirable brown metmyoglobin. Light also has an adverse effect on cured meat pigments and acts, with oxygen, to cause colour fading or discolouration. These reactions are slowed down by lower temperatures.

The higher the intensity of light and the longer the exposure, the greater will be the undesirable colour changes. For this reason, display cabinets should not be over illuminated and the lights should be turned off when the cabinets are not in use. Temperatures as close as possible to freezing should be used.

Since cured meats retain their colour best in the absence of oxygen, films with low permeability to oxygen are commonly used. To get maximum colour retention in a vacuum package, trapped air in or around the product must be avoided (e.g. in the use of comminuted meats, by vacuum chopping).

With cured meats the presence of salt and undissociated nitrous acid inhibit the bacteria that normally cause spoilage of fresh meats. However, spoilage can still occur and for long storage life, vacuum or gas packaging in impermeable films is necessary.

Removal of air by vacuum packaging permits carbon dioxide to build up in the pack to a level similar to that with fresh meat, thus retarding the growth of bacteria. Alternatively, gas flushing with 25 - 40% carbon dioxide would be adequate. Higher levels of carbon dioxide do not adversely affect the colour, but give little additional benefit. Nitrogen percentages close to 100%, and mixtures of nitrogen and carbon dioxide, will also give extended storage life.

COOKED MEAT PRODUCTS

The above comments concerning colour apply to all cooked products, although for slightly different reasons. Oxygen and light are again needed for most of the undesirable colour changes and these changes are slowed down by low temperatures. In the case of bacterial greening of cured products the adverse colour is caused by bacteria which can grow where the oxygen level is low. The green discolouration is a product of the reaction between peroxide produced by bacteria and the nitroso-haemochrome. It occurs only after the consumer has opened the package and the product is exposed to oxygen. The occurrence of greening may be a sign of underprocessing.

As cooked products generally lack any substantial amount of dissolved carbon dioxide, vacuum packaging does not lead to any appreciable accumulation of this gas within the package. Gas packaging is, therefore, commonly preferred. In semi rigid packs, a percentage of nitrogen mixed with the carbon dioxide (e.g. a 1:1 mix of nitrogen and carbon dioxide) is desirable in order to prevent collapse due to carbon dioxide absorption by the meat.

Most cooked meat products are intended for consumption without further heating. Cooking is not a substitute for strict control of hygiene in all phases of preparation, and careful control of temperatures. Particular attention should be paid to:-

- adequately cooking to an internal temperature of at least 150° to 155°F for 10 minutes.
- rapidly cooling the product to below 45°F.

- following hygienic practices in the packaging room: For maximum storage life, it is desirable that the product be cooked in its final package, e.g. chubs. For products that are not cooked in the final package it is essential to keep post-processing recontamination to a minimum. Once packaged, the product is protected from possible recontamination.
- maintenance of temperatures as close as practicable to 30°F during storage, distribution and display.

Thus with processed meats, the lower the permeability of the film to gases, and the lower the oxygen concentration and higher the carbon dioxide concentration in the pack, the longer will be the storage life and the better the appearance. As with fresh meats, storage life of processed meat is related directly to the bacterial load at the time of packaging and the temperature under which the product is held. Once opened, the shelf life of the package is limited. It is important to remember these points and not allow your staff or customers to get a false sense of security.

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NEWS JOTTINGS:

CLEANING AND SANITATION WORKING PARTY

The CSIRO Meat Research Laboratory, Industry Section is conducting Working Parties on Cleaning and Sanitation in Melbourne on 28th and 29th August, 1970 and in Perth on 18th and 19th September, 1970.

The course is intended for Works and Boning Room Managers or their nominees. The aim is to demonstrate a recommended cleaning programme, give the reasons for running such a programme and show how the programme can be tested.

NEXT ISSUE is:

"Batch Process Dry Rendering".

MEAT RESEARCH NEWS LETTER

CSIRO

NUMBER 70/8

DIVISION OF FOOD PRESERVATION,

DATE 7th September, 1970

MEAT RESEARCH LABORATORY,

P.O. BOX 12 (CNR. CREEK & WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170. TELEPHONE 95 2122. TELEGRAMS FOODPRES BRISBANE

BATCH PROCESS DRY RENDERING

For the past 2 years investigations into heat and mass transfer aspects of batch dry rendering have been carried out under the direction of L.S. Herbert, CSIRO, Division of Chemical Engineering.

A standard type batch cooker was used in the trials and most test runs have used normal works rendering procedure which involves charging the cooker with approximately equal quantities of hard offal (crushed heads and bones) and soft offal (mainly guts and paunches) giving an initial water content between 50 and 55%. Cooking proceeds at just above atmospheric pressure until most of the water has been evaporated when, at a point in the cycle indicated by a conductance end point controller (at about 20% water by weight), pressure is applied to the cooker contents. A rapid rise in pressure to 40 psig is followed by a slow depressurisation, with the end of the cook being reached soon after contents pressure has returned to atmospheric. For a typical charge weight of 8,500 lb the cooking time was 2 - 2½ hours, of which about 1½ hours is at slightly above atmospheric pressure and $\frac{3}{4}$ hr at pressures up to 40 psig. The following is an outline of some of the findings:-

In all runs there was a general pattern of variation of heat transfer rate with time from the start of the batch cycle. There was a high initial rate of heat transfer as indicated by the high flow of steam to jacket and shaft, corresponding with a high rate of flow of vent gases. It is believed that heat transfer during this stage is from heated wall to a two phase liquid mixture in which water has free access to the wall - the water being the continuous phase, and oil the disperse phase. After 20 - 30 minutes, the heat transfer rate declined rapidly until at about half-way through

the cycle it was only about 30% of the initial rate, at which low value it remained until discharge. During this stage the liquid phase is oil only, and the remaining water is bound inside particles of solid material. The smaller the particle, the faster will be the drying out and hence particle size is obviously an important variable from the viewpoints of evaporation of water, and of sterilization. Approximately twice as much water was evaporated from the cooker contents in the first hour of cooking time as in the second hour.

The contents temperature reached about 220°F (corresponding to a pressure slightly above atmospheric in the cooker) and remained almost constant until pressure was applied. It increased to a maximum of about 280°F at maximum pressure 40 psig and decreased on depressurisation to 235 - 240°F at time of discharge. In the runs with no pressurisation, the contents temperature remained at around 220°F until the last twenty minutes of the cycle, when there was a rapid increase to 240 - 250°F at the time of discharge.

0.66 - 0.72

Steam consumption varied between 1.2 and 1.3 lb steam/lb water evaporated, equivalent to ~~2.2 - 2.4~~ lb steam/lb charge material of 55% water content. Heat losses from this well insulated cooker were about 150 - 200 lb/hr steam equivalent.

The amount of heat transferred by the shaft was found to be affected by changing the procedure of operation of the shaft steam valve. When the shaft steam valve was left on during the charging period, 25% of the total heat was transferred by the shaft, with the remaining 75% transferred by the jacket. When shaft steam was turned off during the charging period and turned on only when the cooker was fully charged, the heat transfer by the shaft increased to 42% of the total heat. When using the latter method of operation, 1 sq. ft. of shaft surface area was found to be more effective in transferring heat then 1 sq. ft. of jacket area. Heating the shaft when the cooker is only part charged is believed to encourage burning of protein onto parts of the shaft not submerged in the contents.

It appears that an increased shaft speed would result in improved heat transfer rates. However, the present design of steam heated shaft relies on gravity to drain condensate from the beaters and support arms, and the shaft must be run at a speed lower than that at which centrifugal force would interfere with such drainage - in a 5' diameter cooker about 30 rpm. A design of steam heated shaft which incorporated forced drainage of condensate would be operable at higher speeds and should enable higher heat transfer rates to be achieved. For non-heated shafts, an increased speed would be desirable, particularly in the second half of the cycle when the heat transfer is at a low level. At this stage there would be a reduced volume of contents and an increase in speed could be accommodated within the power rating of the existing motors.

Pressure is generally applied as part of a standard cooking procedure. Depressurisation is a time consuming manual operation which increases the cooking time required by at least 15 minutes, and generally much longer. In addition there is some risk of carry-over of contents if the pressure release is too rapid. A simple method of indicating the maximum rate of pressure release has been devised, using the fact that the flow of vent gases through the pipeline to the condenser results in a pressure drop which is proportional to the flow-rate. For example, a pressure gauge at the cooker end of the vent pipe reads about 1 psig when the vent gas flow is about 1,000 lb/hr, and it has been established that this is a safe flow-rate which does not result in carry-over. It is, therefore, possible for the operator to adjust the rate of opening of the vent gas by-pass valve to maintain the pressure in the vent gas line at close to 1 psig, enabling rapid depressurisation to be achieved. A pressure switch has been installed in the vent gas line which gives a green light when the pressure in the line is below 1 psig and a red light when above 1 psig. The operator stops opening the by-pass valve when the red light appears and resumes opening only when the green light reappears. If this method of control proves effective, the electrical signals will be used as the basis for automatic control of depressurisation.

During the experimental programme, samples of meal were analysed for nutritional value and samples of tallow for F.F.A., colour etc. Results to date suggest that time/temperature conditions during cooking are only partly responsible for degradation of product quality; other factors include deterioration of the charge in storage before cooking and product reactions after cooking, for example in percolators and presses.

SUGGESTIONS FOR CHANGES IN OPERATION

The main time factor in dry rendering is for the removal of water by evaporation and for this reason added water from washing etc., must be kept to a minimum. Particle size is also important, since the smaller the size, the more rapidly can water be evaporated from the protein and bone particles during the later stages of the cook.

The following changes appear to be desirable, based on observation of operations on the test cooker. Although this cooker is believed to be typical of batch rendering plants now being used in Australia, care should be taken in applying the suggested changes to cookers in which substantially different charge materials, steam pressures etc. are used:

- Shaft heating permits a substantial increase in throughput. In one run in which 4674 lb water were evaporated from 8400 lb

charge, cooking time with shaft heating was 2 hr 6 min compared with an estimated 3 hr 36 min without shaft heating. On this basis, for an 18 hr day, shaft heating would increase cooker capacity from five to eight batches, an increase of about 60%.

It was apparent that the effectiveness of shaft heat transfer surfaces was greatly reduced by leaving the shaft steam turned on during the ten minutes charging period. To obtain the best results, it was necessary to turn off the shaft steam during the charging period, turning it on only when the cooker was fully charged. Compared to leaving the shaft steam on during charging, this procedure reduced the typical cycle time by about 15%, or approximately 20 minutes.

An increase in shaft speed and the resulting increase in heat transfer rate would be particularly beneficial in the latter stages of the rendering cycle. It is unlikely that existing motors would be overloaded if the speed were to be increased only during the last hour of a two-hour cook.

It is generally not possible to increase the speed of steam-heated shafts, since they must run below the speed at which centrifugal force prevents condensate drainage (about 30 rpm in a 5' diameter cooker). An improved design of heated shaft which drained by steam pressure would allow this speed limitation to be overcome.

Cooker contents are pressurised as part of the standard cooking procedure at many Works. Depressurisation is a time-consuming manual operation which increases the cycle time by at least fifteen minutes and generally much longer. In addition, there is some risk of carry-over of contents if the pressure release is too rapid. In some works, with suitable follow on equipment, pressurisation has been discarded with considerable improvement in cooker operation and no apparent disadvantage in product quality.

However, assuming that pressure application is to be retained, pressure release can be speeded up without risk of carry-over, if the vent pipe pressure is used as an indicator of vent gas flow.

In many rendering plants, there are design faults associated with the size of the steam supply pipes and valves, with condensate drainage and steam trapping and with non-condensable gas removal. Thus, where steam pipelines are under-sized and produce high pressure drop (particularly during periods of high steam flows occurring during the first half hour of the cycle), steam pressure in the jacket and shaft steam spaces is decreased and performance is reduced.

Such losses of performance are generally impossible to assess, since instruments normally fitted are not adequate and there are no entries into cooker or steam lines to enable special tests to be made. A small expenditure on entry points during manufacture and installation of new plants would enable limited but useful performance tests to be carried out.

The CSIRO Division of Chemical Engineering is continuing work on the development of improved rendering processes. Further enquiries may be made directly to Mr. L.S. Herbert, at the CSIRO Division of Chemical Engineering, Lorimer Street, Fishermen's Bend, Victoria.

ACKNOWLEDGMENT:

The active co-operation of management and staff at R.J. Gilbertson Pty. Ltd., Altona is gratefully acknowledged.

* * *

NEWS JOTTINGS:

Cleaning and Sanitation Working Party

The next course is to be held in Perth on the 18th and 19th September, 1970.

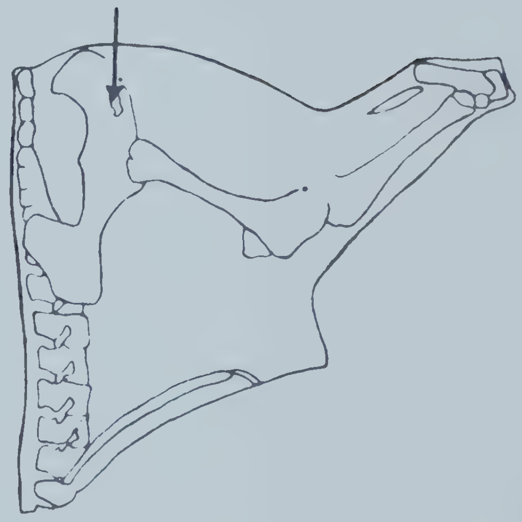
Next Issue is Foam Cleaning.

GETTING THE HANG OF IT!

Meat Scientists at Texas A & M University have recently recommended a method of hanging beef carcases that improves the overall tenderness of the loin, cube roll, rump, thick flank, topside and eye of the silverside. This method consists simply of suspending the hot sides from the aitch bone rather than from the Achilles tendon prior to their entry into the chill room. This method of hanging during chilling causes greater stretching of several muscles than the usual method of suspension.

Normal Suspension by Achilles Tendon

Suggested Suspension by Aitch Bone



It has been known for some time that the way a hot carcase is suspended determines whether particular muscles are stretched during cooling, or are free to contract. Stretching produces more tender meat. The basic research was done some 10 years ago by Locker of the Meat Industry Research Institute of New Zealand, who showed that tenderness is greater in a particular muscle made up of longer units (or sarcomeres) than in the same muscle made up of short units. Locker predicted that different methods of suspension should influence stretching and, therefore, tenderness.

The Texas finding also confirms previous results from the Meat Research Laboratory at Cannon Hill by Kaess, Weidemann and Carruthers. These authors reported in 1967 (J. Food Sci. 32:7-13) that tenderness in certain beef muscles may be partly accounted for by the extent of stretching of the muscles during rigor and ripening.

The effects of different methods of suspending carcases are being examined in current studies of factors influencing tenderness in mutton and beef.

MEAT RESEARCH NEWS LETTER

CSIRO

NUMBER 70/9

DIVISION OF FOOD PRESERVATION,

DATE 6th November, 1970.

MEAT RESEARCH LABORATORY,

P.O. BOX 12 (CNR. CREEK & WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170. TELEPHONE 95 2122. TELEGRAMS FOODPRES BRISBANE

FOAM CLEANING

A recommended procedure for the cleaning and sanitation of meatworks was outlined in Meat Research News Letter 70/4, and it was suggested that one way of applying detergent to the surface to be cleaned was to use foams.

What is Foam Cleaning?

Foam cleaning is no more than a method of applying a detergent solution to the surface to be cleaned. It should not be regarded as a magical procedure whereby foam is thrown over all work surfaces and then all soil is just rinsed off to leave a perfectly cleaned surface. It is only one step in a cleaning procedure, allowing a small quantity of the chosen detergent to be spread over a large area, to give a greatly increased contact time with the dirt to be removed and to provide visual evidence that the detergent has reached all surfaces.

The Advantages of Foam Cleaning include:

- Cost saving in detergent used compared to other methods of application.
- Reduction in water used.
- Reduction in labour.
- A much longer contact time of detergent.
- Visual evidence of areas covered.

- It enables the cleaning of areas (e.g. walls, ceilings) which are difficult to reach.

The Disadvantages include:

- The initial capital expenditure.
- Heavily soiled surfaces cannot be cleaned without mechanical action.

In areas of heavy soilage (e.g. fat build up, scaling on equipment), some mechanical action will be necessary to allow the detergent to emulsify and suspend the dirt from the surfaces. In all cases mechanical action will greatly assist the speed with which the detergent will perform its task. In short, there is no substitute for hard work in the removal of dirt be this supplied by good old fashioned elbow grease, or by the use of high pressure rinse water to the softened dirt.

Equipment for Producing Foams

Foams are formed in special equipment by the action of compressed air on a dilute solution of detergent and foaming additive. There are several brands of equipment for the formation of foams and these fall into 3 basic categories.

(1) Venturi-feed Foam Guns (e.g. Dema Foam Gun, Gibson Microfoamer, Oakite Drum Type Foamizer).

A concentrated detergent solution and foam additive is drawn into a water stream by the vacuum created by water passing through a Venturi valve, and the detergent and foam additive mixes with the water stream to make a dilute detergent-foam additive solution. This is passed by venturi effect into a stream of compressed air and foam is formed.

There are some disadvantages of the venturi feed system and these include:

- A limitation on the strength of a detergent solution that can be prepared in a concentrated form, and a consequent limitation on the strength of the detergent in the foam.
- Highly concentrated solutions of solid detergents are harder to dissolve, with consequent clogging of the inadequately sized filters provided (too small in surface area and usually the holes are too large).

- Undissolved detergent particles clog the valve entry into the water stream with resulting failure to operate, or reduced performance.
- The equipment needs fairly constant flowing air and water pressures to create stable foams. Fluctuation in either pressures can result in rapid changes in the nature of the foam from sloppy liquid to dry floating foam.

The advantages of this type of equipment are:

- Low cost relative to other types (generally range \$90 - \$150).
- Easy maintenance; simple to dismantle to effect running repairs.
- Entire assembly is stainless steel, with no glands or seals.

(2) Pressure-fed Foamer (e.g. RTM Foamer)

A concentrated detergent-foam additive solution is forced by air pressure from a pressure vessel via a regulating valve into the water stream. The supply of detergent solution can be seen in a glass-covered sight vessel. The dilute detergent-foam additive solution is then foamed in a chamber by forcing the detergent through a valve into the air stream.

The advantage of this equipment is:

- Less chance of variation in balance of water and air pressure. However, where water pressure fluctuates greatly, difficulty in regulating is still encountered.

The disadvantages are:

- The unit requires higher concentrations of foam additive to achieve satisfactory foams than is required by either the Venturi-feed equipment or the air-pressure pump equipment.
- The pressurized chamber holds a volume of about 3 gallons and requires frequent refilling. This involves releasing the pressure.

(3) Air-pressure Pump Fed Foamers (Graco Pressure Pump with foaming unit, Applied HV Foamer).

A dilute solution of detergent and foam additive is pumped at the desired rate (this can be varied) through a valve into an air stream in a foaming chamber. By varying the delivery speed of the air pressure operated pump it is possible to make a foam to the desired consistency and stability.

The disadvantages of this type of equipment are:

- High initial cost ($850 - $1200).
- The need to make detergent solutions frequently, 40 gallons of prepared detergent solution will cover approximately 6,000 sq. ft.
- With moving parts there is a possibility of mechanical problems. These air pressure pumps are reported to give difficulty with glands and seals but no trouble has been reported in the meat industry.

The advantages of this type of equipment are:

- Operates on air pressure only and therefore is not affected by water pressure.
- It is possible to make more concentrated detergent foams than with the other types of unit because the detergent is foamed directly from the reservoir.
- Detergent solutions can be heated to desired temperature in the reservoir before application.
- By simple adjustment, the pressure pump can be used as a high pressure rinsing or detergent application system.
- The equipment can be operated at pressures of about 80 psi, and at higher pressures can spread the detergent foam quickly allowing much faster coverage of areas.

The type of unit to choose will be dependent largely on the scale of operations. In a small boning operation without compressed air supply for example, it would probably be economically impractical to purchase even a small unit because of the cost of a compressor.

Foam Additives

All detergent manufacturers stock one or more foam additives to mix with detergents for use in the foam generating equipment. These materials vary greatly in cost, and in the quantity needed to make satisfactory foams. It is advisable to check the compatibility of the detergent proposed for use with the foaming additive before any attempt is made to use it in cleaning operations. In general, acidic detergents and highly alkaline detergents (or high concentrations of mildly alkaline detergents) require more foam additive to create stable foams. The use of warm to hot water (120 - 140°F) results in more generous production of foam from an equivalent concentration of foam additive than is obtained with cold water.

Stability of Foams

The stability of a foam is determined by the type of foam additive, the type of detergent and its concentration, the temperature of the water, the ratio of detergent to water, the type of surface it is foamed onto (smooth or rough), the temperature of the surface (hot or cold) and there are probably many other factors affecting the stability of the foam.

General Points on Foam Cleaning

Foam should be regarded as a maintenance cleaning method. It will not successfully clean very dirty surfaces. It will maintain clean surfaces if they are foamed regularly and if there is judicious use of the appropriate alkaline and acid detergents. The method is rapid and permits one to cover relatively large areas (e.g. chillers, meat markets) with reasonable speed.

Most standard equipment throws out a concentrated stream, but by modification to the nozzle it has been found possible to spread foam evenly and thinly to give a larger coverage in a shorter time. A design for a wand to incorporate a commercially available nozzle is available from the Laboratory and this will spread foam in a 6 - 8 ft. span dependent on the air pressure.

A technical report 2/70 on evaluation of foam-additives and foaming equipment has been issued to industry and this gives some more detailed information.

The savings in labour and detergents and the results attainable using foams as part of a cleaning method are impressive and management would be well advised to consider foam cleaning.

NEWS JOTTINGS:

CORRECTION! - some alert industry people have noted an error in our News Letter 70/8 on Dry Rendering. Page 2 third paragraph should read "Steam consumption varied between --------- 0.66 - 0.72 lb steam/lb charge material of 55% water content".

The International Organisation for Standardisation has put out a number of recommendations concerning analysis of meat and meat products, including animal fats:

R 932 Animal Fats - Determination of Insoluble Impurities.

R 933 Animal Fats - Determination of Moisture and Volatile Matter.

R 934 Animal Fats - Determination of Water.

R 935 Animal Fats - Determination of Solidification Point of Fatty Acids (Titre).

R 936 Meat and Meat Products - Determination of Ash.

R 937 Meat and Meat Products - Determination of Nitrogen Content.

Copies can be obtained through The Standards Association of Australia, Standards House, 80 Arthur Street, North Sydney, 2060.

The Next News Letter will be CLA (Cheesy Gland).

IEAT RESEARCH NEWS LETTER

SIRO

NUMBER 71/1

ISION OF FOOD PRESERVATION,

DATE 4th February, 1971

AT RESEARCH LABORATORY,

OX 12 (CNR. CREEK & WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170. TELEPHONE 95 2122. TELEGRAMS FOODPRES BRISBANE

ABATTOIR EFFLUENT TREATMENT

Effluent treatment in abattoirs has become an important subject because of the possible introduction of regulations to minimise pollution. This Newsletter is intended to give a general outline of the means by which water-borne wastes may be treated.

The meat industry uses large quantities of water and recent figures indicate that usage can be in excess of 1000 gals./ 1000 lb. dressed weight. This water is a significant processing cost factor. Additionally, treatment in the works is a further cost and measures should be taken to minimise the volume of water used. Disposal to sewers represents another significant cost.

Effluent water from meat processing plants is still almost pure water in which the concentration of effluent solids is usually expressed in parts per million (p.p.m.), which is directly equivalent to lb. per 100,000 gallons and mg. per litre.

MEASUREMENT OF BIOLOGICAL POLLUTION

A measure of the organic strength of any effluent is its level of Biochemical Oxygen Demand (B.O.D.). This is defined as "the quantity of oxygen required for the stabilization of the oxidizable organic matter present", and is normally determined after incubation at 20°C for 5 days. The higher the B.O.D. level the greater is the quantity of organic matter in the water and the greater is its pollution capability.

Some idea of the polluting potential of the waste water from a meat processing plant is given by the fact that whilst normal domestic sewage has a B.O.D. level of 200-300 p.p.m. the average wasteload at the saveall is in the region of 1500-2000 p.p.m. - i.e. to reduce the effluent to a similar level to that of domestic sewage would require a B.O.D. reduction of approximately 85%. To meet a possible statutory requirement of 20 p.p.m. B.O.D. for effluent discharged to an inland waterway would require a B.O.D. reduction of approximately 99%.

WASTE WATER LOADS

A 1967 American publication (U.S. Department of the Interior) categorizes the U.S. meat packing industry into types of technology in relation to their in plant practices and the effect of these types of technology on waste water loads :

Typical Technology	Advanced Technology
1. Recovery of all blood	Recovery of all blood
2. Wet dumping of paunch material followed by hauling away of the gross paunch material	Dry dumping of paunch material followed by hauling away of the gross paunch material
3. Edible rendering - dry rendering or wet rendering with evaporation of tank water	Edible rendering - low temperature
4. Inedible rendering - dry rendering	Inedible rendering - continuous dry rendering
5. Wet clean-up	Dry clean-up followed by wet clean-up

The waste water volumes and loads per unit of product for each case were given as follows :

Type of Technology	Wasteload lb. B.O.D./1000 lb. L.W.K. *	Waste water gal./1000 lb. L.W.K.	B.O.D. Concentration p.p.m.
Typical	19.2	1080	1780
Advanced	15.1	930	1620

* Liveweight kill

The approach to the problem of effluent treatment starts within the plant, not at the saveall. It is far easier and cheaper to prevent gross contamination of the water than it is to treat the contaminated water leaving the plant. Plants should continually look at means to minimise the quantity of waste in water and the quantity of water used. A plant with efficient by-product

recovery and dry clean up will be able to get the waste load below 15 lb. per 1000 lb. live weight kill into the saveall. A waste water usage of less than 1000 gal. per 1000 lb. live weight kill is obtainable. Therefore works should be aiming for a B.O.D. concentration into the saveall in the region of 1500 p.p.m.

It should be remembered that the waste waters may also contain certain chemicals which would affect their use for irrigation and limit their final discharge to some water courses and sewerage schemes. For example, phosphate and nitrate create difficulties in certain effluent treatments since they stimulate the growth of algae.

Systems for the treatment of meat works effluent are many. In some cases it may be possible to transfer the effluent to a local authority plant for final treatment but even this may involve on-site treatment to reduce the effluent B.O.D. concentration to a level equivalent to that of domestic sewage.

PRIMARY TREATMENT

The first step in any treatment plant should be to screen and settle out solids and to remove the fats. Fat removal can be done either by hand, mechanical skimming or dissolved air flotation and information available indicates that the flotation process is economically justified :

Reduction in	Skimming	Air Flotation
fats	30-50%	70-90%
suspended solids	40-50%	50-65%
B.O.D.	10-20%	20-35%

SECONDARY TREATMENT

The selection of the most suitable system depends upon costs and many factors such as land area available and the B.O.D. level required in the final effluent as determined by the particular means of disposal.

1. ANAEROBIC PROCESSES - the reduction in B.O.D. being performed by microorganisms which function in the absence of oxygen.

Ponds: These are generally deep, the trend being towards a depth of 15 ft. This type of pond is generally used for initial treatment and can be loaded to 15 lb. B.O.D. per 1000 cubic ft. of pond volume giving a B.O.D. reduction of 60-80%. The advantages of this method are low capital cost with high B.O.D. reductions being achieved with reasonable land area requirements. Against these should be set the possibility of high odour levels and a high level of suspended solids in effluent. The process operates most efficiently at an elevated temperature, approximately 90-95°F.

Contact Process: The effluent is digested at a temperature of 90°F in an enclosed digestor vessel, the gases produced being burnt and the heat generated used to maintain the working temperature.

Typically, contact plants have B.O.D. loadings up to 20 lb. per day per 1000 cubic ft. of digestor volume, detention time 12 to 13 hours and a sludge return of up to three times the raw effluent flow. With effective sedimentation a B.O.D. reduction of 90-95% can be achieved.

The disadvantages of this method are high capital costs, difficulties associated with sludge separation and the need to maintain steady waste load rates.

2. AEROBIC PROCESSES - the reduction in B.O.D. being performed by microorganisms which function in the presence of oxygen.

Ponds: These are shallow with a depth of 3 to 4 ft. and having a loading of 40-50 lb. B.O.D. per day per acre of pond surface.

Aerobic ponds are seldom used for the initial treatment of effluent. They are mainly restricted to use as a final treatment following other processes where a high quality terminal effluent is required. This is due to the large land areas required, high evaporation losses from the surface and the possibility of seepage.

Activated Sludge Process: involves the aeration of screened, pre-settled effluent mixed with a small volume of activated sludge drawn from a subsequent sedimentation basin. This method has been used to treat domestic sewage but very few plants exist that treat meat plant effluent alone.

The capital and operating costs are high and great care must be taken to avoid fluctuations in waste load. The plant generally must be under the supervision of well trained operators.

Channel Aeration (or Pasveer) Process: is a modification of the activated sludge process, treatment taking place in a continuous channel 3 to 6 ft. deep, loaded at the rate of 30-40 lb. B.O.D. per 1000 cubic ft. of channel volume per day with a detention time of 2-3 days.

Surface aerators ensure oxidation and continuous movement of the waste to keep the bacterial sludge in suspension. B.O.D. reduction better than 95% is possible but is dependent on detention time.

The advantages of this system are lower capital costs, the ability to accept fluctuations in load and the production of a stabilized sludge which may be processed for feed meal. The main disadvantage is the need for large areas of land.

3. BIOLOGICAL FILTRATION PROCESSES

Percolating Filter: in its conventional form, a filter consisting of stones packed on a bed about 6 ft. deep is in general use for the treatment of domestic sewage. The function of the percolating filter is to bring into contact the organic pollution content of the effluent and microorganisms capable of utilizing it in the presence of oxygen.

At loadings of 150-180 lb. B.O.D. per 1000 cubic ft. of packing per day a B.O.D. reduction of approximately 40% is possible. The process has a high capital cost, has a tendency to block unless double filtration is adopted, and requires large areas of land.

Plastic Packed Filters: have been developed to overcome the problems associated with the stone packed filters. Constructed of P.V.C. with large void spaces this allows much higher loading rates. Loadings of 230-250 lb. B.O.D. per 1000 cubic ft. of packing give a B.O.D. reduction of 75%.

Two stages of filtration and sedimentation are reported to give 85% B.O.D. reduction and three stages 95% B.O.D. reduction.

The cost of the packing media is high but is partially offset by the small amount of civil work required. The big advantage is the ability to stack the plastic filling to a height of 20 ft. thereby reducing the ground area required.

BACTERIAL POLLUTION

Effluent contains numerous bacteria and contamination of livestock drinking water with the effluent must be avoided.

Ideally, the first step in any proposal to treat effluent is to accumulate data on flow rates, B.O.D., fats and suspended solid levels over a period of time. It is not sufficient to specify a system on the basis of assumed flow rates, etc. All possible steps to minimise both the water usage and the amount of solid wastes in the effluent should be considered and put into effect before determining design data for a treatment plant.

The measurement of flow rates can be easily carried out by means of standard weirs, the operation being either manual or automatic. Drawings are available indicating the construction and dimensions of suitable units and can be obtained from this Laboratory at a cost of 50 cents per set.

The Meat Research Laboratory has just commenced an investigation into effluent flow rates and B.O.D. levels. It is hoped

that this will provide information on which to base the design of the most suitable and effective effluent treatment plants for meat industry wastes.

U.S. Department of the Interior, Federal Water Pollution Control Administration, "The Cost of Clean Water", Vol. III, Industrial Waste Profiles, No. 8 - Meat Products

NEWS JOTTINGS

Divisional Re-organisation

CSIRO Laboratories concerned in research associated with the food industries are now all grouped in a Division of Food Research. This new CSIRO Division of Food Research includes the Meat Research Laboratory in Brisbane; the Food Research Laboratory centred in Sydney; and the Dairy Research Laboratory in Melbourne, formerly the Division of Dairy Research.

Next issue will be Shipment of Chilled Beef Cuts.

MEAT RESEARCH NEWS LETTER

SIRO
VISION OF FOOD RESEARCH
EAT RESEARCH LABORATORY,
BOX 12 (CNR. CREEK & WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170. TELEPHONE 95 2122. TELEGRAMS FOODPRES BRISBANE

NUMBER 71/2

DATE 22nd March, 1971

SHIPMENT OF CHILLED BEEF CUTS

The export shipment of chilled beef cuts has grown in importance over the last year, and the availability of containers has been the major factor in opening up markets. The first trial shipment was made in 1968 to Japan and this grew to a total of 545 tons exported to Japan in the last half of 1970. Shipments during the first two months of 1971 suggest a rapidly growing interest in these chilled cuts. All cuts are now being exported in varying quantities and some exporters have found a storage life as long as 10 weeks in some circumstances.

Vacuum packs in air impermeable films extend the storage life by about 2½ times the period possible in air. They have the advantage of minimising weight loss whilst allowing ageing during this safe distribution life.

Spoilage can occur and it is appropriate therefore to review matters which contribute to success or failure :

a) PRESLAUGHTER TREATMENT: It is important that cattle are slaughtered in a rested condition and that the hides of the animals are clean in order to minimise carcase contamination.

b) SLAUGHTER AND DRESSING: The usual hygiene precautions apply.

c) CHILLING OF SIDES: The dressed sides should be promptly transferred to the chiller, the surface temperature quickly reduced, and the bone temperature reduced to 50-55°F within about 24 hours, depending on the size of the side. Keep chiller doors closed when not in use, do not allow sides to touch and do not push hot sides in with cold. Under proper refrigeration, it is not critical whether the meat is boned in 24 or 48 hours. It is desirable that all parts of the meat and fat are below 50°F before boning begins, and if necessary, the meat should be held longer than 24 hours to achieve this. However, every additional day beyond 48 hours will reduce the storage life by at least 2 days.

d) CLEANING AND SANITATION: All cleaning and sanitation recommendations must be followed from slaughter to sealing in the pack, particularly on those surfaces that contact meat.

e) BONING AND PACKAGING: Dark cutting beef should not be packed because it has a shorter storage life. Bag, vacuum and seal meat within half an hour of boning. For successful storage it is important to remove the air, and manufacturers' instructions should be followed as to bag and clip size and vacuum and sealing technique. Cartons or cases should not be overfilled and cuts should be handled carefully and as little as possible in order to prevent breakages.

f) CHILLING OF CUTS: For extended storage life the meat must be promptly chilled below 36°F. Prechilling of the room down to, say, 25°F may be practical in some circumstances. Where the required storage life of the cuts is close to the limit, they should be chilled singly on shelves, in which case the centre meat temperature should get below 36°F within about 24 hours. Temperature checks should be made by inserting a thermometer into the centre of test packages. Test packages and any "leakers" detected on the shelves should not be rebagged for outlets where long storage life at chiller temperature is necessary. Always keep the fat surface uppermost and the neck of the bag up.

Where maximum storage life and minimum drip is required, it is important to reduce the temperature of the meat rapidly to the lowest possible value without causing freezing. Signs of freezing in cuts will occur at between 29.5°F and 30.5°F.

Where extended storage life is not important, cuts may be packed direct into cases or cartons from the sealing machine or shrink tunnel, first ensuring that the bags are dry and that seals are satisfactory. This minimises handling and reduces costs. Chilling in the outer carton or case will take longer and give a subsequent reduction in storage life. It is not advisable to pack direct into outer cartons or cases if "leakers"

Chilled beef in air impermeable vacuum packs can be prepared and stored safely at 35°F for about 5 weeks, or at 31°F for about 7 weeks, from slaughter to consumption. Longer periods may sometimes be possible depending on both type and numbers of initial contaminating bacteria at the time of packing. In difficult to evacuate packs shorter periods may only be possible.

Exporters should advise the importer of the risks of extending the distribution period especially if the recommended temperatures are not attained.

It is important to remember that once the seal on the bag is broken, the meat has only a very limited storage life.

CONCLUSION:

The shipment of chilled beef cuts in vacuum packed air impermeable bags to markets as distant as the U.K. is quite practical. To achieve successful long storage life proper attention has to be given at all stages during preparation, storage and distribution. Until distribution channels of known times and temperatures have been worked out exporters would be wise to use the lowest possible temperature without causing freezing of the meat (i.e. 30.2°F). When an established routine has been set, higher temperatures (up to 35°F) could be specified when shipment and distribution time is less than 7 weeks. The actual temperature will then depend on the efficiency with which the pack is evacuated, the type and number of contaminating bacteria and the storage and distribution life required.

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Technical Report 1/71, "A Low Cost Transportable Bacteriological Incubator" has been prepared and distributed to the Meat Industry.

Next issue is - BONE TAINT.

MEAT RESEARCH NEWS LETTER

CSIRO

DIVISION OF FOOD RESEARCH

MEAT RESEARCH LABORATORY,

O. BOX 12 (CNR. CREEK & WYNNUM ROADS), CANNON HILL, BRISBANE, QLD. 4170. TELEPHONE 95 2122. TELEGRAMS FOODPRES BRISBANE

NUMBER 71/3

DATE 17th May, 1971

BONE TAINT

Bone taint still occurs sporadically in beef and pork carcases in Australia but there does not appear to be much difference in the incidence now and that before the days of export boning. The occurrence of bone taint is a reflection on poor quality control since it is due to faulty processing through inadequate chilling of the carcase after slaughter.

Bone taint is usually typified by putrid and sour odours which develop under certain conditions in the deep parts of the tissue near the bone. Sometimes this is accompanied by a greenish discolouration of the meat. The taints are due to a variety of bacteria (mainly clostridia) which can grow in the absence of oxygen.

CONDITIONS CONDUCIVE TO BONE TAINT:

The development of taint depends primarily on two factors :

1. Firstly, the bacteria associated with bone taint have to be present. Spoilage tends to be concentrated in the fat and connective tissue surrounding the major blood vessels and lymph nodes and this suggests that the infection is distributed through the blood stream and lymph system. Thence the bacteria can move deep into the muscles or into the bone marrow and synovial fluid (joint oil) of the knee joint.

The most likely way for them to get into the blood stream and lymph system is through the live animal's gut wall. Conditions likely to facilitate this movement are fatigue, stress and prolonged starvation. It has been found that the average numbers of bacteria in each lymph node is higher when the rainfall for the two months prior to slaughter has been low. This may be due to a higher concentration of air and dust borne organisms or it may be related to some nutritional factor affecting resistance to infection.

A second possibility is that the organisms may enter the blood stream during sticking with a contaminated knife. The bacteria introduced here might come from faeces or from dirt on the hide or skin of the animal.

With pigs it is also possible that intestinal bacteria gain access to the carcase through the slit in the neck during immersion in the scalding tank.

Besides these routes of entry it is possible that similar organisms might be introduced during the dressing operation (e.g. during "cupping" of hot carcases) and during the curing operation in the case of pork (e.g. infected pickle solution).

2. Secondly, growth of the bacteria has to occur in sufficient numbers after penetration into the deep tissues. This can only occur under suitable conditions of temperature and acidity :

a) Temperature: For adequate control the rate of cooling of the deep tissues is likely to be decisive. Usually the types of bacteria which produce bone taint grow rapidly at around the hot carcase temperature (103°F), only slowly at 55-60°F, and not at all at below 40-50°F.

Slow chilling after slaughter permits excessive growth. Thus bone taint is more common in heavy animals, particularly those with thick fat cover, since chilling of deep tissues is slower in this type.

b) Acidity: The bacteria grow best in neutral conditions and their growth is markedly reduced in acid conditions (pH below 6.0). Thus bone taint is more likely to appear in meat from stressed or fatigued animals, such as in dark cutting beef (pH above 6.0). However, there is little risk of taint in the meat provided it is properly chilled; in the case of beef to a deep butt temperature of less than 60°F in under twenty hours.

CONCLUSION:

Fatigue or stress of the live animal and a slow rate of cooling in the resultant carcase is conducive to bone taint. Restriction of bacterial growth and prevention of the production of taint can be achieved by :

* Adequately resting animals prior to slaughter.

* Reducing the carcase bone temperature as soon as possible to 55-60°F. To avoid overloading chillers, Management should be sure to advise the Engineer when any heavy lines of cattle are being killed.

Reduction in temperature soon after slaughter is particularly important since this is the period when the acidity, although increasing, is still relatively low and favourable to bacterial growth.

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NEXT ISSUE IS :

Fouling of Evaporative Type Condensers; Its Effect and Prevention.

ABSTRACTS

Below are some abstracts of recent publications which may be of interest. Copies of publications are restricted to the Australian Meat Processing Industry and can be obtained by completing the attached form. Payment must be made in advance.

1. BLOOD, Ruth M. Salmonellae in Foods. British Food Manufacturing Industries Research Association: Scientific and Technical Surveys, No. 60, 1969. 45p.

Foods most frequently reported to be the vehicles of infection for Salmonella food poisoning are, in the main, protein-based foods derived from meat animals or poultry. Although the level of salmonellae in contaminated foods is frequently extremely low, even a low level may present a potential hazard if the food is mishandled prior to consumption, for example, providing conditions such that the organisms will multiply. Contaminated foods (or ingredients) may in themselves be incapable of supporting the growth of these organisms but may become part of a composite food which can support growth. A process of cross-infection from contaminated food to previously uncontaminated material may also occur. The purpose of this paper is to collate much of the information available in the literature on the incidence of salmonellae in foods.

2. LEDWARD, D.A., NICOL, D.J. & SHAW, M.K. Microbiological and Colour Changes During Ageing of Beef, Food Technology in Australia, 23: 30-32 (1971). 3p.

Ageing of beef promotes improvements in tenderness and flavour during storage. The storage periods required to produce a significant increase in tenderness frequently exceed the maximum period for which the meat can be held in air without bacterial spoilage. Means of extending storage without weight loss, or colour deterioration, are discussed.

3. Frozen Food Coordinating Committee, Code of Recommended Practices for the Handling of Frozen Food, Washington, D.C. 10006. 11p.

These recommended practices relate to merchandising aspects of frozen foods and are based upon findings of extensive research in frozen food time-temperature-tolerance by the Western Utilization Research and Development Laboratory of the United States Department of Agriculture conjointly with the Refrigeration Research Foundation. They are sound and practical for application to those food products intended to be sold in frozen state.

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P.O. Box 12, Cannon Hill, Qld., 4170.

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4. Send this form and remittance (10¢ per page made out to the "Collector of Monies, CSIRO") to the above address.

EAT RESEARCH
NEWS LETTER

SIRO
IVISION OF FOOD RESEARCH
EAT RESEARCH LABORATORY,
. BOX 12, CANNON HILL, BRISBANE, QLD. 4170. (CNR. CREEK AND WYNNUM ROADS). TELEPHONE 95 2122. TELEGRAMS FOOD RESEARCH BRISBANE

NUMBER 71/4
DATE 14th June, 1971

FOULING OF EVAPORATIVE TYPE CONDENSERS
- ITS EFFECTS AND PREVENTION

Refrigeration is the most essential engineering service in the meat processing industry. Management is therefore committed to ensure that the service is available when required and is at its most efficient operational level, i.e. lowest power consumption per ton of refrigeration effect.

BASIC REFRIGERATION CYCLE

Refrigeration is achieved in the basic vapour compression cycle by the circulation of a fluid (Ammonia, etc.) at varying temperatures and pressures as indicated in Fig. 1.

It is important to note that all stages in the cycle are interdependent and any change in conditions at any one stage must necessarily result in changes throughout the entire system.

CONDENSERS

Evaporative type condensers are widely used in the meat processing industry mainly because of their relatively low initial cost and the lower vapour condensing pressures possible which result in lower operating costs.

Both air and water are employed in the evaporative condenser. Water is recirculated from a sump, and pumped as a spray over the coils containing the high temperature refrigerant vapours. Heat is removed from the refrigerant inside the coils and transferred to the recirculating water. Some evaporation of the water occurs aided by a forced flow of air over the outside of the coils.

The condenser is simply a heat exchanger and like all similar units must be kept clean at all times if maximum performance is to be maintained.

Reductions in heat transfer rate can be caused by :

a) scale build up

b) accumulation of suspended solids and biological growth which may develop on the water side of the coil

EFFECT OF FOULING

The effect of fouling may be best shown by examining the basic heat transfer equation :

$$Q = U \times A \times \Delta T$$

Where Q = total heat transferred Btu/hr

U = overall heat transfer coefficient $\mathrm{Btu/ft^2hr^oF}$

A = heat exchange area $\mathrm{ft^2}$

ΔT = mean temperature difference between refrigerant and water ^oF

For a particular condenser the area A is constant. If fouling occurs the value of U must decrease. For the refrigeration system to operate at its designed capacity the heat dissipated, Q, must remain constant. It is therefore obvious that the temperature difference between refrigerant and water ΔT must increase. If the design water and air temperatures are maintained this increase can only be met by an increase in the compressor discharge temperature. As temperature and pressure in the refrigeration cycle are mutually dependent, then the pressure must also increase. In an ammonia system a condensing temperature of 95°F requires a pressure of 181.1 psig and a temperature of 105°F, 214.2 psig.

This increase in pressure leads to :

increased running costs
reduction in cooling capacity due to a drop in the volumetric efficiency of the compressor at higher pressures
high pressure cut out of the compressor
excessive wear of equipment
higher maintenance and replacement costs

Manufacturers of evaporative condensing equipment normally allow a "fouling factor" of 0.0005-0.001.

The "design" value of the overall heat transfer coefficient of a condenser is obtained by combining the "clean" value and the fouling factor (Rf) in the following equation :

$$\frac{1}{U} = \frac{1}{Uo} + Rf$$

Where U = overall heat transfer coefficient (Btu/ft^2hr^oF) - design value

Uo = overall heat transfer coefficient (Btu/ft^2hr^oF) - clean condenser

However, under adverse conditions of operation, e.g. high water hardness, poor control, etc., fouling factors can rise to much higher values than those used by the designer.

The significance of this can best be explained by substituting two values of Rf in the above equation assuming Uo = 100 Btu/ft^2hr^oF.

Rf = 0.001 U = 91 Btu/ft^2hr^oF

Rf = 0.004 U = 71 Btu/ft^2hr^oF

i.e. with the increase in fouling factor from .001 to .004, the overall heat transfer rate must drop from 91 to 71 Btu/ft^2hr^oF, a decrease of 22%.

PREVENTION OF FOULING

A programme of preventive maintenance can maintain the fouling factor at or below design values.

Such a programme would involve the following :

(a) Bleeding-off a proportion of the cooling water continuously. This is most important as it prevents the accumulation of dissolved and suspended solids left by the water evaporated by the unit. In typical installations bleeding-off of approximately one percent of the cooling water circulated in the unit is satisfactory but this depends on the quality of the water.

(b) Chemical treatment of the water to control corrosion and scale. Calgon is suggested as a suitable treatment for corrosion prevention. The slowly soluble type is preferred as it is simply suspended in a basket in the

sump water. The rate at which it dissolves is such that topping up is required only once a month.

(c) Chemical treatment of the water to control biological growth. Biological growth inhibitors should be applied as shock treatments in adequate doses to prevent resistant strains of algae and other microorganisms from growing. A weekly charge of a suitable compound is normally adequate.

(d) Regular cleaning and descaling of the heat transfer surface. This can be achieved by wire brushing all accessible surfaces to remove loose materials and by the application of alkaline detergents and, later, inhibited acids to the sump water followed by flushing with clean water.

As the materials of construction and cooling water characteristics vary from plant to plant the recommendations of a specialist water treatment chemical supplier should be obtained. Proprietary products are available for all the above treatments and these treatments should be repeated at regular intervals as required.

REFERENCES

CZARNECKI, J.T. "Fouling in open spray cooling systems" Paper presented at Australian Institute of Refrigeration Air Conditioning and Heating Federal Conference, 1969.

CZARNECKI, J.T. "Maintenance of open spray cooling systems" CSIRO Division of Mechanical Engineering, Internal Report No. 43A.

NEWS JOTTINGS

The Industry Section of the Laboratory is investigating sampling procedures for boneless meat using the core method. Results will lead to a recommendation as to the number of cores to be taken and the number of cartons that must be sampled out of a production lot.

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NEXT ISSUE:

A Corer for Sampling Cartoned Boneless Meat.

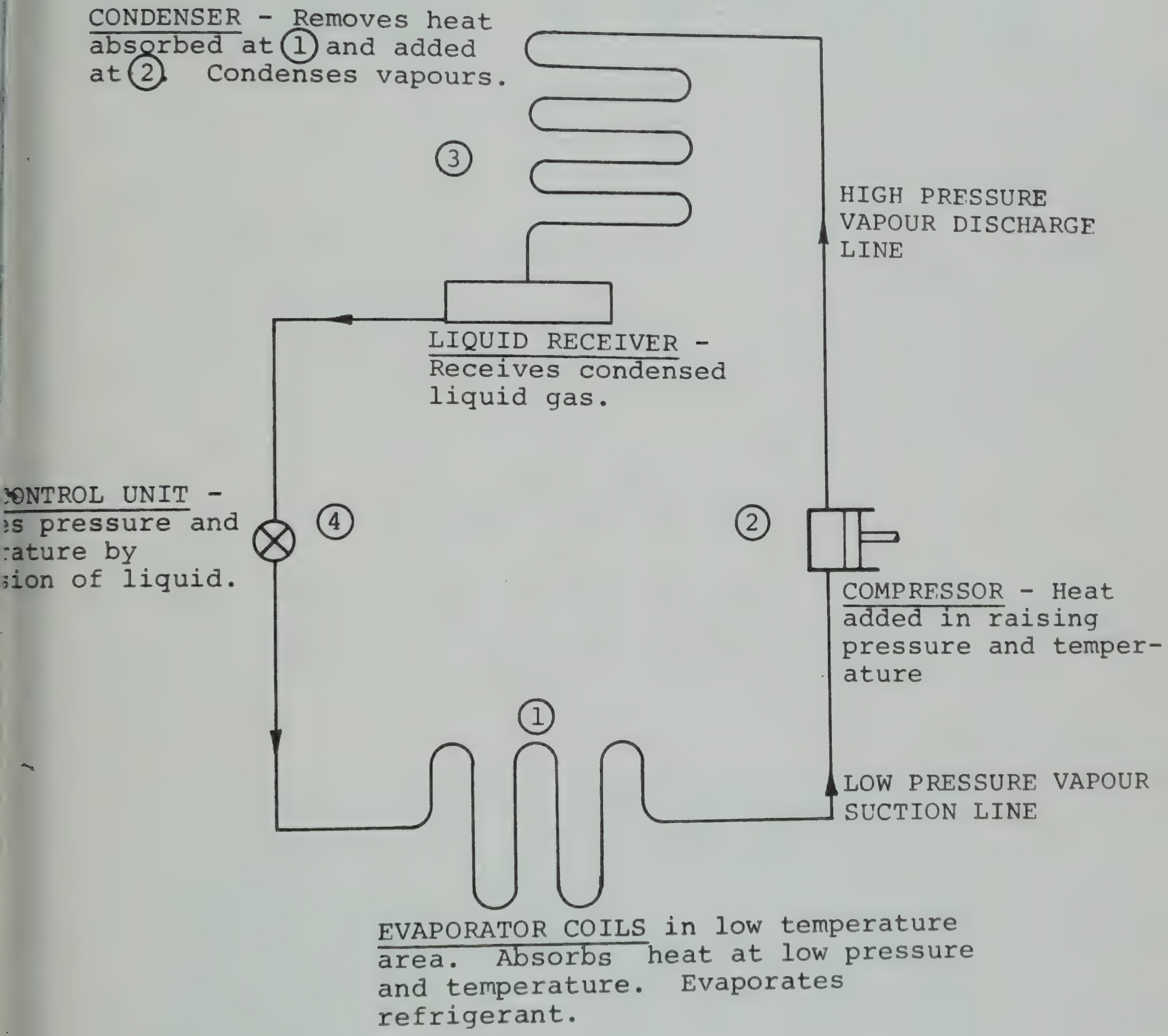


FIG.1 BASIC VAPOUR COMPRESSION CYCLE

MEAT RESEARCH NEWS LETTER

CSIRO

DIVISION OF FOOD RESEARCH

MEAT RESEARCH LABORATORY,

P.O. BOX 12, CANNON HILL, BRISBANE, QLD. 4170. (CNR. CREEK AND WYNNUM ROADS). TELEPHONE 95 2122. TELEGRAMS FOOD RESEARCH BRISBANE

NUMBER 71/5

DATE 5th July, 1971

A CORER FOR SAMPLING OF CHILLED BONELESS CARTONED MEAT

It has been found that removing cores of meat from cartons is a satisfactory method of sampling for fat estimation. Using a corer attached to a light electric hand drill, and a template, core samples amounting to about 1% of the carton weight are removed.

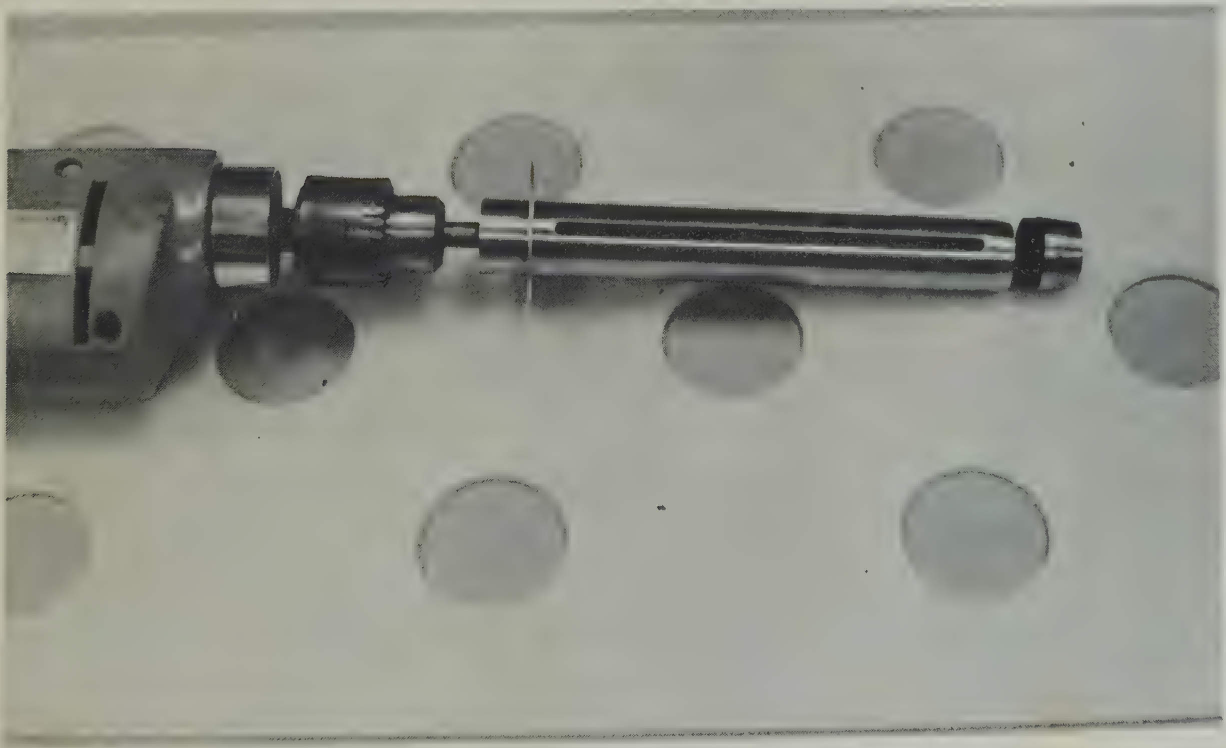


Fig. 1 - Coring equipment showing hand drill, corer tube and tip, resting on a template.

To ensure the withdrawal of a standard representative sample the corer should have a flange attached to it so that the tip reaches the bottom of the carton but is prevented from going through the liner. However, some works do go right through the carton and repack. It is also necessary to incorporate some provision for ejecting the meat sample from the tube in the design, e.g. a slot in the side of the tube along which a knife can be inserted. A 1" O.D. x 18 SWG solid drawn 316 stainless steel tube threaded at one end on the inside for the attachment of the coring tip and with a spindle to fit into the drill chuck at the other end, is recommended (see Fig. 1).

Faults seen in many works were that the corer tip was blunt and that there was no means of effectively sharpening the tip to a sufficiently keen edge. To overcome these problems the work done by CSIRO Wool Research Laboratories, Division of Textile Physics (H.W. Lunney, Pressure Coring of Baled Wool, The Textile Journal of Australia, Vol. XXXV, No. 6, p662, August, 1960) was applied to sampling of meat.

CORER TIP DESIGN:

Fig. 2 shows a cross-section (not to scale) of a corer tip and part of a tube. It will be noted that the throat of the tip contracts in a slow taper, and the throat exit expands abruptly to the internal diameter of the coring tube, which is slightly greater than the cutting diameter. These proportions provide easy progress of the cores into the tube and easy travel upwards. The cutting diameter is made as large as possible in relation to the outside diameter of the tube. This maximises the weight of core for a given tube size and minimises effort wasted in friction on the cheek of the tip and on the outside of the tube.

The criteria of tip design can be summarised :

(1) Sharpening angle (angle between lands), is 40-50 deg.;

(2) Inlet diameter is chosen to give this angle with bronze balls of standard size;

(3) Inlet and exit diameter are less than the tube bore;

(4) External taper (cheek angle) is less than 8 deg.;

(5) Short parallel portion on outside allows for regrinding of external taper.

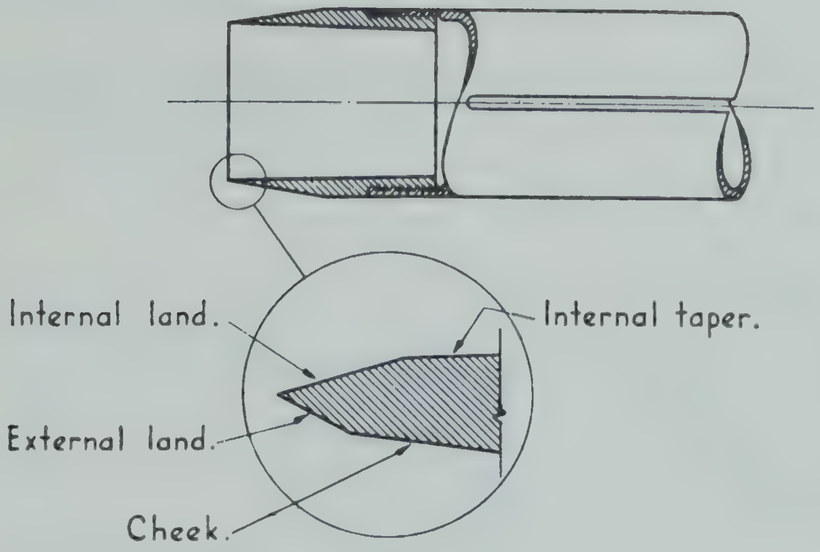


Fig. 2 - Section of coring tip and portion of tube showing slot for insertion of a knife. Inset shows "lands" generated in the sharpening process.

Coring tips (0.9") for screwing into 1" O.D. coring tubes can be obtained at a cost of 1.15. 0 from Benson Verniers Ltd., Carlton Works, Carlton St., Bradford 7, U.K. We have been unable to find a source of supply in Australia or New Zealand.

SHARPENING METHOD FOR TIPS FITTING 1" O.D. TUBE:

The equipment is shown in Fig. 3.

Fig. 3 - Sharpening equipment showing hand drill and sharpening ball, charging ball and sharpening

It consists of :

(1) The sharpening ball fitted with a stem (Fig. 4) held in the chuck of an electric drill.

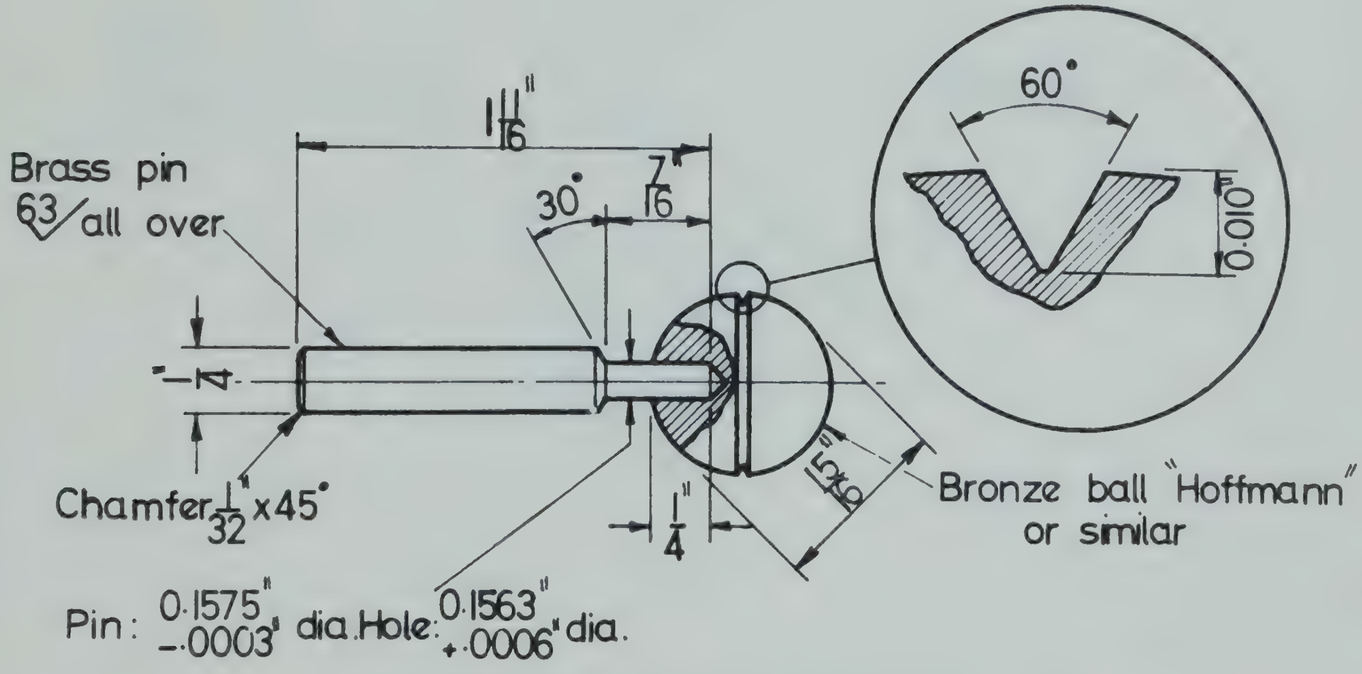


Fig. 4 - Detail of sharpening ball.

NOTE: Charging ball and Sharpening Ball. Sphere to be shrunk on to pin. Temperature difference between pin and sphere 55°C. Hole for pin to be accurately radial in ball.

(2) The charging ball (Fig. 5) used in lapping the sharpening cup into truly spherical form.

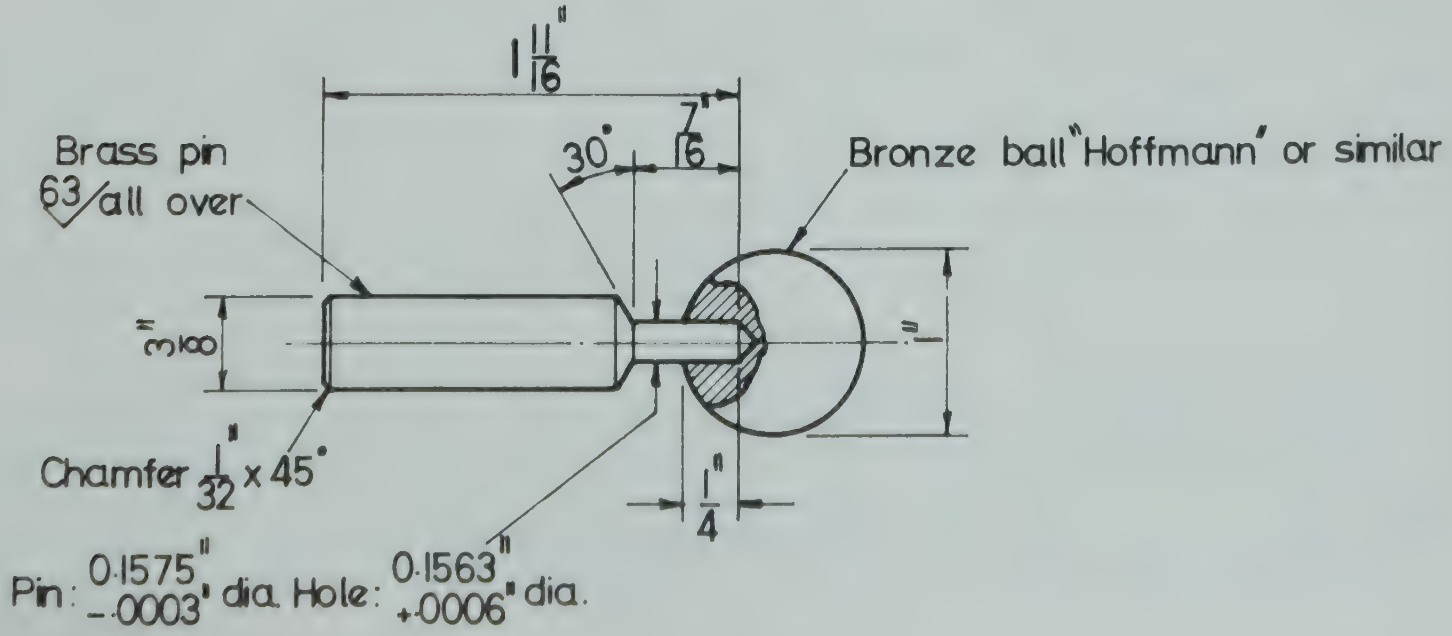
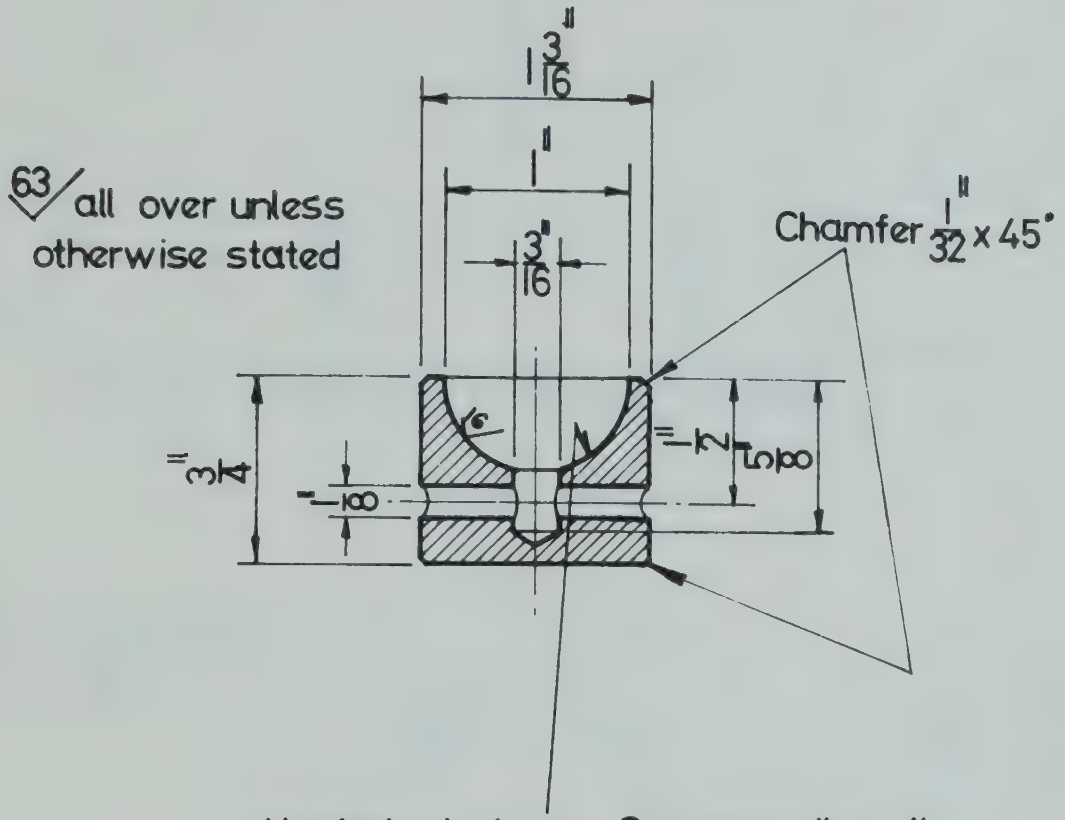


Fig. 5 - Detail of charging ball.

(3) <u>The sharpening cup</u> (Fig. 6) <u>and holder</u> (Fig. 7).



Hemispherical cup: Corresponding dia. charging ball to be running fit in cup. Depth of cup may be up to 0.010" less than hemisphere.

Fig. 6 - Detail of cup (cast iron).

GENERAL:

The technique is that an external "land" is generated on the tip by lapping in the sharpening cup, and an internal "land" by lapping on the sharpening ball. An abrasive compound such as 400 grit aluminium oxide in a water soluble cream is used. To sharpen the internal land the ball held in the chuck of the drill is turned with gentle pressure on the coring tip. The tip is held at a high angle to the axis of the ball and is allowed to rotate slowly as the ball is turned.

Continued success with coring depends on maintaining tips in a sharp condition. The person sampling carries a number of tips and when one becomes dull a fresh one is screwed into the coring tube. All tips are resharpened at the end of the day. Care should be taken to clean and sanitize the tips after each sharpening. The threads should be oiled regularly with an edible oil.

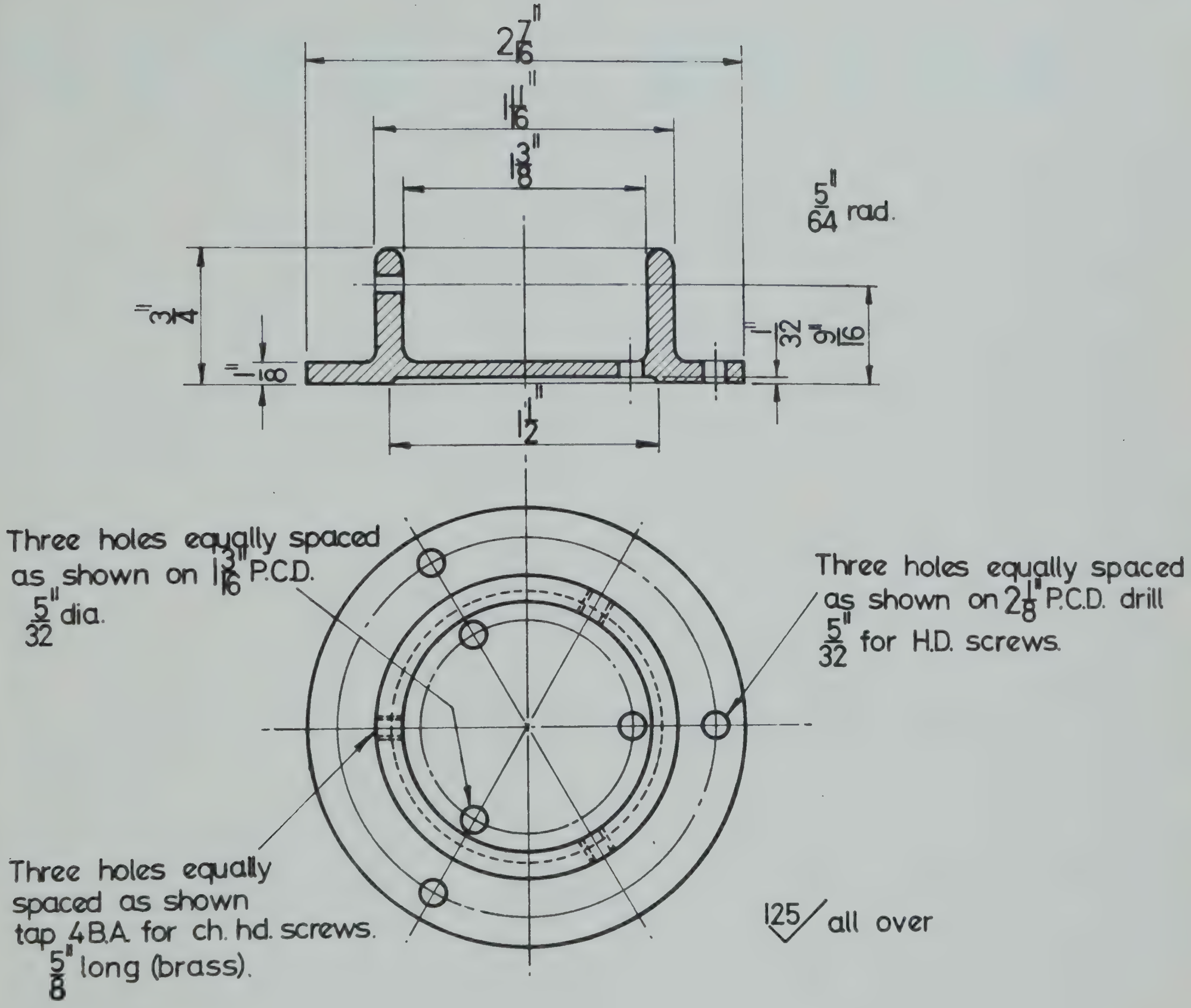


Fig. 7 - Detail of cup holder (brass).

NOTE: Surface finish symbols to be in accordance with B.S.308 & B.S.1134. Surface finish may be interpreted :

125✓	medium machine
63✓	fine machine
16✓	fine grind, hone or lap

NEXT ISSUE:

Greening of Vacuum Packed Fresh Meat - Causes and Prevention.

MEAT RESEARCH NEWS LETTER

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CSIRO

DIVISION OF FOOD RESEARCH

MEAT RESEARCH LABORATORY,

P.O. BOX 12, CANNON HILL, BRISBANE, QLD. 4170. (CNR. CREEK AND WYNNUM ROADS). TELEPHONE 95 2122. TELEGRAMS FOOD RESEARCH BRISBANE

NUMBER 71/6

DATE 9th August, 1971

GREENING OF VACUUM PACKED FRESH MEAT

- CAUSES AND PREVENTION -

Greening of fresh meat during ageing or transit at chiller temperatures is caused by bacterial action. There are two types -

SULPHMYOGLOBIN GREENING:

This type of greening is caused by the bacterial production of hydrogen sulphide (H_2S or "rotten egg" gas) from sulphur containing compounds in the meat. To date it has been found only in meat with a pH of 6.0 or higher and to be caused by organisms which can produce greening only at low oxygen concentrations. In some recent investigations into sulphmyoglobin greening other types of bacteria have been isolated from high pH meat. These are being examined to determine the conditions under which they can produce H_2S from meat and thus cause greening.

Any hydrogen sulphide produced reacts with the red pigment in the muscle (myoglobin) to produce a green coloured pigment (sulphmyoglobin). This dark green pigment is particularly noticeable in the weep or drip in the plastic film bags. On opening the plastic bags there is a very noticeable smell of hydrogen sulphide and this smell cannot be mistaken for the normal "aged" meat smell found in practically all 'cryovac-aged' beef.

The green sulphmyoglobin reverts to another type of red pigment on exposure to oxygen (oxysulphmyoglobin), and the colour returns to an apparently "normal" red appearance. The smell tends to disappear from the surface of the meat, but in samples examined in the laboratory the odour of hydrogen sulphide was detectable on cutting the surface of the meat.

Thus to obtain this type of bacterial greening it is necessary to have -

(a) Sufficient numbers of bacteria capable of producing hydrogen sulphide. These bacteria need not be the predominant types in the bacterial flora - they may only be 1 to 10 percent of the population.

(b) Meat of high pH value, 6.0 and above ("dark cutting").

(c) Low oxygen concentration - less than 1 percent - as is found in a cryovac bag. Some organisms capable of producing hydrogen sulphide only do so at low oxygen concentrations. At higher oxygen concentrations any green pigment formed is immediately converted to a red pigment.

FLUORESCENT PIGMENT GREENING:

Some pseudomonad organisms produce a water-soluble green fluorescent pigment, but to do this they require highly aerobic conditions. Thus, efficient vacuum packaging of fresh meat will stop this particular type of greening.

However, this type of greening may still occur if a bag is badly evacuated, punctured or leaks.

PREVENTION OF SULPHMYOGLOBIN GREENING:

To prevent greening of meat and drip proper attention should be given to all processing procedures. In particular -

(a) Cleaning and Sanitation of plant and equipment in accordance with the steps outlined in Newsletter 70/4 is imperative. The bagging and air evacuating equipment need special attention and a recommended daily procedure for nozzle type air evacuating equipment is -

1. Dry clean the whole general area where the equipment is located, removing meat scraps and packaging materials, etc.

2. Wet all surfaces with warm water (120°F).

3. Clean individual units.

   (i) Remove the nozzles and treat separately.

   (ii) Fill a plastic bag with approx. ½ gallon of warm water (120°F) and flush the water through the machine into the vacuum tank. Remove the vacuum tank, empty and replace it.

   (iii) Flush with ½ gallon of chlorinated detergent solution made up to manufacturers recommended strength. Run approx. ½ the detergent solution into the equipment, take a bottle brush and scrub the inside of the tube. Flush through the remaining detergent. Allow to stand for 5-10 minutes, remove the vacuum tank, empty it and replace.

   (iv) Flush through ½ gallon of sanitizer solution containing approx. 200 parts per million of available chlorine (sodium hypochlorite or isocyanuric acid), or any other USDA approved sanitizer made up to manufacturers recommended strength.

   (v) Remove the vacuum tank, wash it in chlorinated detergent, rinse in warm potable water and then in sanitizer solution, air dry in an inverted position. Ensure that the lip area is drained.

4. Clean the nozzles in the chlorinated detergent solution, ensuring that the small holes in the sides of the vacuum nozzles are thoroughly cleaned. Rinse in warm potable water and soak for at least 10 minutes in a sanitizer solution.

5. Clean all the stainless steel equipment, tops of machines, stainless steel tables and loading prongs with a solution of chlorinated detergent.

6. Rinse all equipment with warm potable water.

7. Apply a sanitizer solution to the surface of all equipment. Either rinse this off with warm potable water as a terminal operation at night or allow the sanitizer to remain in contact with the equipment overnight and rinse the surface before use. Ensure that no free moisture is left on the surface of equipment at the commencement of work.

8. At the mid-day break the nozzle should be removed from the machine and cleaned using procedure No. 4 above.

If sanitizers other than chlorine based ones are used it is advisable to interchange types regularly (say monthly) since some bacteria may develop resistance to any other sanitizing agent used continuously. Strip papers are available from your supplier of detergents for checking the chlorine content of sodium hypochlorite solutions. In order to ensure that the cleaning programme is functioning effectively it is essential that microbiological testing of equipment be done at regular intervals.

(b) Meat of ultimate pH 6.0 or higher should not be used for vacuum packaging (refer Newsletter 69/10). A trained operator can pick out a high percentage of this type of meat by its dark colour. However, the only way to be certain of detecting high pH cuts is to use a pH meter. Most Laboratory suppliers stock pH meters and names can be obtained by contacting the Meat Research Laboratory.

The cube roll or strip loin is a suitable cut to appraise as its pH can be measured at quartering prior to boning and is typical of other primal cuts. It should be noted that the ultimate pH (48 hr post mortem) of these muscles is about 0.2 pH unit lower than that at 24 hr post mortem. The shins, neck muscles and intercostals generally have an ultimate pH above 6.0 and these should therefore not be vacuum packed.

In addition to the above, aspects of processing and storage mentioned in Newsletter 71/2 should be carefully noted. Prevention of greening can only be achieved through quality control to ensure correct processing and handling.

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NEWS JOTTINGS:

The names of Australian manufacturers prepared to make the boneless meat sampling coring tip and other equipment mentioned in Newsletter 71/5 can be obtained by writing to the Meat Research Laboratory.

- o O o -

NEXT ISSUE:

Temperature Measurement in Abattoirs.

MEAT RESEARCH NEWS LETTER

CSIRO

DIVISION OF FOOD RESEARCH

MEAT RESEARCH LABORATORY,

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NUMBER 71/7

DATE 20th September, 1971

TEMPERATURE MEASUREMENT - THERMOMETERS

INTRODUCTION:

Temperature, in the simplest sense, is a measurement of the ability of a body to lose or gain heat, heat itself being a form of energy. It is possible for a body to lose heat in three ways, usually with a consequent lowering of temperature.

a) CONDUCTION: Heat transfer within a body from a region of higher temperature to one of lower temperature. For example, in cooling carcases heat flows from the bone to the surface by conduction. Since meat is a poor conductor, cooling takes a long time.

b) CONVECTION: Heat transfer from a body to its gaseous or liquid surroundings. For example, when carcases are cooled in a chiller there is convective transfer of heat from the carcases to the air surrounding them. Convective heat loss can be accelerated by removing the air as it becomes warm and replacing it with cold air.

c) RADIATION: Heat transfer from one body to another body by virtue of the temperature difference between them. The mechanism is quite different from conduction or convection. It requires no material medium between the two bodies for this form of heat transfer to take place. For example, when standing near a steam line one receives most heat by radiation.

In the majority of cases all three heat transfer mechanisms occur simultaneously; thus heat from near the bone in a carcase hanging in the cool room flows to the surface by conduction. It is then transferred from the surface by convection to the air and by radiation to the walls of the chiller and to other carcases around it if these are at lower temperatures.

There is an important exception to the rule that heat transfer results in a temperature change. In the process of freezing and evaporation large quantities of heat have to be transferred without a change in temperature of the body.

Temperature measurement and control are important aspects of the overall management of a modern abattoir, and their importance is increasing with the increasing application of technical methods in day-to-day operations. A thermometer is a device incorporating a scale by which temperature can be measured. There are two common scales, Celsius (or Centigrade) and Fahrenheit, but within a few years because of adoption of metric measurements we will only be concerned with the Celsius scale. A table showing equivalent temperatures on the Celsius and Fahrenheit scales forms an appendix to this report.

TYPES OF THERMOMETERS:

The many types of thermometers available are described in Table 1.

PRECAUTIONS TO BE OBSERVED IN MEASURING TEMPERATURES:

a) Make sure that the temperature measured is not misinterpreted.

For example, the meat on an exposed surface will rapidly approach the cold air temperature, whereas the meat furthest from the surface may remain warm for several hours. Care should be taken to ensure that the most sensitive area of the thermometer is at the point from which information is required.
The most sensitive point of bimetallic spear thermometers is some distance from the tip, e.g. with "Tel-Tru" dial types it is at a point midway between the tip and the groove cut about $^2/5$th of the way up the stem. In thermistor, thermocouple and liquid in glass types the most sensitive point is at the tip.

b) Use accurate equipment which is tested frequently.

The thermometer may become inaccurate with use, so that it is advisable to check its working range against a calibrated thermometer at regular intervals (bimetallic spear types should be checked at least monthly). Another simple method of checking is to immerse the thermometer in a mixture of ice and clean tap water. As long as ice and water are both present, the temperature of the mixture will be 0°C (32°F). If the thermometer is more than 1° out, allowance must be made for this when making subsequent measurements.

c) Always repeat measurements.

Make check readings at least once after replacing the thermometer in the position of measurement. In measuring the temperature of objects, e.g. carcases, always measure the temperature of several of them and average the results.

d) Allow the instrument time to settle down.

Stabilisation can often take a considerable time. An initially cold thermometer pushed into warm meat may take many minutes to arrive at the temperature of its new surroundings; the larger the size of the thermometer, the greater is this "thermal inertia" effect, and the more pronounced the lag until the true temperature is indicated.

e) Always insert thermometers along the longest thermal path possible (i.e. the longest path from the point to be measured to the surroundings). This avoids errors due to conduction from point to point within the body. This may arise when the body is not in temperature equilibrium and has large temperature gradients within it, e.g. in the initial stage of chilling.

f) Take measurements where there are no large temperature differences between body surface and surroundings.

This avoids the error due to conduction between points within the body to the surroundings. For example, temperatures in cartons of frozen meat measured at dockside may be substantially above the correct values unless special precautions have been taken to avoid conduction errors.

NEXT ISSUE:

Temperature Measurement in Abattoirs.

TABLE 1

THERMOMETER TYPE AND METHOD OF OPERATION	ADVANTAGES	DISADVANTAGES
a) EXPANSION:		
1) Liquid in glass - Bulb and hollow stem containing liquid - mercury or alcohol (usually as spear type for carcases or in a carrier for air temperatures)	cheap portable maintenance free direct reading fast response	fragile calibration drift not for remote sensing not physically flexible spear thermometers have large conduction errors sensor is large
2) Liquid in metal and vapour pressure - Hollow bulb and capillary tubing of metal connected to a pressure sensor - usually a Bourdon tube (fluid, mercury or nitrogen)	remote sensing easily read (using indicator) chart recorders	expensive slow response occasional difficulty if mountings changed vapour pressure type respond extremely slowly if temp. oscillates
3) Bimetallic - Spiral of two metals of different thermal expansion bonded together. One end of the spiral is fixed while the other is attached to a spindle. The exterior end of spindle is fitted with a pointer moving over a circular scale.	cheap portable robust	not very accurate high stem conduction errors mechanical pointer may stick not satisfactory for remote sensing

b) ELECTRICAL:		
1) Resistance Thermometers - Resistance changes with temperature. Resistance changes measured with circuitry and meters.	when encapsulated, are robust highly accurate if circuitry is suitable useful for remote sensing	large sensor size expensive slow response low sensitivity requiring special circuitry for most measurements
2) Thermistors - Special metal oxide beads, resistance changes with temperature. Quite different to wire wound resistance thermometers.	small size quick and easy reading high sensitivity small portable robust instruments narrow probes minimise conduction errors (<1/16" in some cases)	more costly than spear or bimetallic portable units need batteries
3) Thermocouples - Wires of two dissimilar metals joined at their ends. One end is heated with respect to the other and a voltage difference is set up. This gives a measure of the temperature difference between the ends of the wires.	probes cheap and easily made remote sensing small size - good response	costly sensitive detection equipment cannot be wetted unless encapsulated frequent calibration required

APPENDIX

TEMPERATURE EQUIVALENTS TABLE
CELSIUS (CENTIGRADE) AND FAHRENHEIT SCALES

C	F	C	F
-40	-40	55	131
-35	-31	60	140
-30	-22	65	149
-25	-13	70	158
-20	-4	75	167
-15	+5	80	176
-10	14	85	185
-5	23	90	194
0	32	95	203
		100	212
5	41		
10	50	110	230
15	59	120	248
20	68	130	266
25	77	140	284
30	86	150	302
35	95		
40	104		
45	113		
50	122		

$$\text{Deg C} = \frac{5}{9}(F - 32)$$

$$\text{Deg F} = 32 + \frac{9}{5}C$$

MEAT RESEARCH NEWS LETTER

CSIRO

DIVISION OF FOOD RESEARCH

MEAT RESEARCH LABORATORY,

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NUMBER 71/8

DATE 29th October, 1971

TEMPERATURE MEASUREMENT - MEAT

The control of temperature during chilling, holding, freezing and storage can have significant effects on the quality (tenderness flavour and microbial status) of meat and meat products. Some aspects of the effects of temperature on various aspects of meat processing were mentioned in previous newsletters - See 68/1, 69/1, 71/3, 71/7.

The accurate determination of the temperature of meat and meat products is a basic requirement for adequate temperature control. Some precautions have to be observed in measuring the temperature of carcases and of cartoned meat and these are discussed below.

THERMOMETERS:

Meat temperatures can be measured with bimetallic or liquid-in-glass spear thermometers but both of these types can have considerable errors. Excessive conduction errors occur with liquid-in-glass spear thermometers and these are not recommended. Thermistor systems using long (over 6"), narrow (less than $^1/8$") stainless steel probes are better, but are more expensive. They require batteries to operate but are easily read and usually fairly robust.

Some points to remember :

a) Calibrate all types of thermometers frequently.

b) Make sure the sensitive portion of the thermometer is placed in the zone in which temperature measurements are needed.

c) Insert the thermometer along the "longest thermal path". This avoids or minimises conduction errors along the stainless steel probe from hot to cold regions or from cold to hot regions (these conduction errors can be very large).

d) Avoid measuring temperatures of materials where there is a large temperature difference between them and the environment. For example, if the temperature of frozen cartoned meat on a landing or wharf prior to shipment is measured with a spear thermometer whose stem is in direct sunlight or hot atmospheric situations the reading will be considerably higher than the true product temperature. Conversely, with products warmer than the environment but undergoing cooling, e.g. if the temperature of meat which is warmer than the freezer is measured in a blast using a spear thermometer whose stem is exposed to the air, the reading will be considerably lower than the true product temperature. These errors can be avoided by using thermistor probes whose conduction errors, when used in a reasonable manner, are negligible.

e) Leave the thermometer in place until the temperature stabilises. In some cases this may require 5 minutes.

CARCASE TEMPERATURES:

CHILLED: Surface temperatures are difficult to measure accurately. The use of tip measuring thermometers permits approximate surface measurements to be made. Deep butt temperatures are usually measured to follow the progress of chilling. The technique illustrated in Fig. 1 allows accurate location and gives satisfactory readings. It is advisable to take readings on several carcases in different parts of the one chiller in order to obtain a general temperature. The average result will be more reliable than a single reading, which may not be typical for a variety of reasons.

FROZEN: Drill a hole into which the thermometer shaft fits neatly so that the thermometer makes good contact with the meat particularly at the sensing point. Push the thermometer in tightly. Drill shavings can be used to pack the hole if it is oversize. Care should be taken in measuring the temperatures of frozen materials in freezer stores since conduction along the stem of the thermometer can result in inaccurate measurements. Use long thin probes and insert along the longest path possible to the point of measurement. Maximum temperatures should be measured and this occurs, usually, at the centre. Measure deep butt temperatures as above.

CARTONED FROZEN MEAT TEMPERATURES:

Frozen products in cartons should be checked at frequent intervals to ensure that the contents are fully frozen. All temperature measurements should be taken at carton centre and the thermometer inserted as indicated in Fig. 2. Drill a tight fitting hole in the centre of the end or side of the carton using a clean stainless steel spike or hand drill with a stainless steel bit. Insert the thermometer along the long axis of the carton taking care to ensure that the middle of the sensitive portion of the stem is at the centre of the carton in good contact with the meat. It is frequently impracticable to use the longest axis of the standard cartons and the next longest axis should then be used, (i.e. the side as shown in the diagram). Care should also be taken in measuring meat temperatures in freezer stores when large diameter thermometers are used.

PROCESSED MEAT TEMPERATURES:

The same principles as in the above cases should be applied.

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The USDA have recently issued "Guidelines for Chilling, Freezing, Shipping and Packaging Meat Carcases and Meat Byproducts" Individual copies are available from the USDA, C & MS, Washington, D.C. 20250, or bulk orders can be obtained from - The Superintenden of Documents, U.S. Government Printing Officer, WASHINGTON, D.C. 20402, U.S.A., at 10 cents each. Stock No. 0100-1379.

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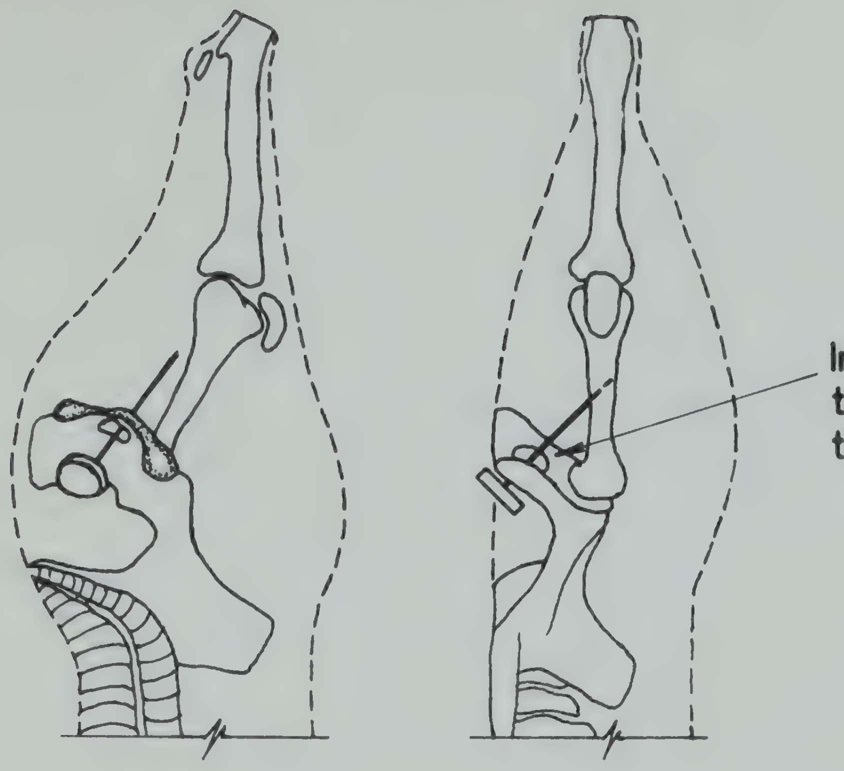
NEXT ISSUE:

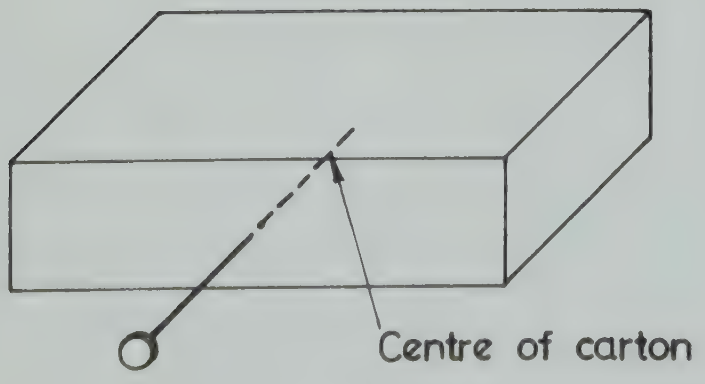
Control of Salmonella in Meat Meal.



Insert 8"-stem dial type thermometer upward through hole in aitch bone.

METHOD OF DEEP BUTT TEMPERATURE MEASUREMENT

FIG. 1



Insert 8" thermometer in centre of end or side of carton

METHOD OF CENTRE CARTON MEASUREMENT

FIG. 2